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BRITISH SURGICAL PRACTICE

SURGICAL PROGRESS 1956

Under the General Editorship of

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PUBLISHERS' ANNOUNCEMENT

THIS 1956 *Progress Volume* is the sixth of an annual series of supplements to *British Surgical Practice*. By this means the eight volumes of the main work are kept up to date in the ever-increasing field of surgical knowledge by original articles, critical surveys and abstracts.

The Noter-up section will guide the reader to all supplementary articles or to critical surveys of each subject mentioned in the main work; this also applies to all abstracts. Non-subscribers to the main work will still find the Noter-up section of value, in that it is arranged alphabetically, and at a glance, information can be gained from the publication of all recent material on any particular subject. Consequently, the *Progress Volume* can be used independently.

Every article in the main volumes of *British Surgical Practice* has a Key Number, which appears at the commencement of each chapter and also at the top left-hand corner of every right-hand page. In order to ascertain whether there has been any recent advance in the particular subject to which reference is being made, the reader should merely turn to the appropriate Key Number which appears in the left-hand margin of the Noter-up section. He will there find either a note that no further references appear or information as to the type of new matter incorporated by way of article, survey or abstract. This is amplified by a brief outline of the content of the recent addition.

Subscribers who turn direct to the abstract section will find that here also the keyed arrangement has been followed.

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PARTIAL NEPHRECTOMY - - - - -	PAGE 189
H. HAMILTON STEWART, M.A.Cantab, F.R.C.S. The Urological Department, Bradford Royal Infirmary	
PARALYSIS OF THE LARYNX - - - - -	224
J. C. HOGG, F.R.C.S. Surgeon, Ear, Nose and Throat Department, St. Bartholomew's Hospital, London, Surgeon, Royal National Throat, Nose and Ear Hospital, London	
MELANOMAS AND THEIR SPREAD - - - - -	236
CECIL W. D. LEWIS, M.B., M.Ch., B.Sc., F.R.C.S. Senior Lecturer in Surgery, Welsh National School of Medicine, Honorary Surgeon, The United Cardiff Hospitals	
PANCREATITIS - - - - -	249
WALTER C. MACKENZIE, M.D., C.M., F.R.C.S.(C.), F.A.C.S. and G. LESLIE WILLOX, M.D., F.R.C.S.(C.), F.A.C.S. University of Alberta Hospital, Department of Surgery	

PART III—ABSTRACTS

ADHESIONS AND CICATRICAL STENOSES—VEINS, VARICOSE - - -	263
---	-----

NOTER-UP, 1956

INDEX

INTRODUCTION

SURGICAL PROGRESS may take the form of modifications and improvements in well-established methods of treatment, or of entirely new techniques and original means of dealing with problems not hitherto amenable to surgery. The present volume contains examples of both these forms of progress, and we are greatly indebted to our colleagues for their willing and generous collaboration in placing their experience at our disposal.

The more novel subjects which are much in the public eye are represented by Mr. Potter's informative and beautifully illustrated chapter on spontaneous intracranial haemorrhage, Mr. Pyrah's article on ureteric transplantation, which we hope may be followed in due course by further reports of his experience in using the intestine for various purposes in urinary surgery; the article by Dr. Scurr and Dr. Organe on hypothermia, and Mr. Hamilton's account of partial nephrectomy, an operation which when skilfully performed in properly selected cases must be regarded as a triumph of conservative surgery. Mr. Sharrard's article has been included because we believe that it throws a flood of light on the interpretation of paralysis in poliomyelitis and has a direct bearing on the management of the disease. It illustrates one of the advantages of an annual progress volume in that some subjects can be dealt with at a length which would have been disproportionate in the original presentation of surgery as a whole. Mr. Muir's method of treating rectal prolapse deserves to be regarded as an entirely new approach to an old problem; and the work of Mr. Patey and Dr. Thackray on parotitis breaks new ground as well as correcting previous misconceptions. Mr. Chin's article on congenital deformities of the thorax and their treatment deals with a subject to which there has not been any previous reference in *British Surgical Practice*.

The remaining articles are of value because they help to bring up to date subjects which, though mentioned in the original volumes, must be re-described in the light of subsequent experience. They are the interesting review of pancreatitis by Dr. Walter Mackenzie and Dr. Leslie Willox of the University of Alberta, the chapter on melanoma by Cecil Lewis, recently appointed Professor of Surgery at Perth, Western Australia, the descriptions of the treatment of intestinal cancer by Mr. Hogg and of

cedures omitted from the earlier volumes and now described by Mr. Barron. The order in which these contributions are mentioned is not to be regarded as an indication of their relative importance, for to grade them in this fashion would be well-nigh impossible. They are all valuable contributions to *British Surgical Practice*, but their relative value must vary according to the practice and interests of those who read them. It is our hope that all surgeons may find something of interest in this volume.

E. ROCK CARLING
J. PATERSON ROSS

BRAIN-SPONTANEOUS INTRACRANIAL HAEMORRHAGE

BY JOHN M. POTTER, M A, M B, B.CHIR., F.R.C.S.
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INTRODUCTION

In few other clinical problems can there be so much doubt and so little that is certain as in the case of intracranial haemorrhage which is not of traumatic origin. Such evidence as there is concerning prognosis and the efficacy of various methods of treatment has been interpreted as supporting different viewpoints, and it is not surprising, therefore, that agreement should not yet have been reached concerning the place of surgery in the management of these cases. Experience has chastened the more enthusiastic advocates of early surgical intervention, to the extent that the tendency now is more to try to protect the patient from further haemorrhage than to attempt heroic, but usually unrewarding, operations to stop bleeding that is already in progress. While it is believed that surgery may help these patients, by attention to lesions that are a likely source of recurrent haemorrhage, sufficient time has not yet passed to assess to what extent it does so.

The account that follows is intended more as a guide to general principles and to recent trends in the subject than as an attempt to give either a clear-cut, dogmatic policy or a review of the many differing (and confusing) practices that may be encountered.

The particular leanings of individual physicians, who usually have an earlier responsibility than the surgeon for these cases, must inevitably be reflected in an account of any surgical series, and practical considerations, such as bed-space and operating time, will determine how much of this type of work a particular surgeon is able to undertake, for these often desperate cases are numerous, and the rewards are as yet unpredictable. Moreover, it must be said that a certain skill and patience are required of the operator if the dangers of surgery are to compare favourably with those of conservative treatment—the dividing line between the two may yet prove to be finer than it is at present thought to be.

AETIOLOGY AND PATHOLOGY

Aneurysms

"Berry" aneurysms (as Sir James Collier aptly named them) are much the commonest lesions for which surgery may be considered in cases of spontaneous haemorrhage. The irregular, fusiform arterial dilatations that are associated with arteriosclerosis do not really concern us, and syphilitic aneurysms of the cerebral arteries were probably rare even when syphilis was common. Mycotic aneurysms are also uncommon; they are usually small and situated at the periphery of the middle cerebral arterial tree; and the causative infection, chiefly subacute bacterial endocarditis, will generally have been recognized.

Only the "berry" aneurysms will be considered further.

Origin and mechanism of rupture

There are two main views about the origin of these so-called congenital aneurysms. The first, largely due to Forbus (1930), is that they are, in fact, "acquired lesions based upon a fundamental predisposing factor in the form of a congenital arterial structural imperfection, a defect in the muscular coat, characteristically located at points of bifurcation". The persistent, saccular dilatation follows stretching and degeneration of the internal elastic lamina. The importance of this deficiency of the muscle has since been disputed, and to many the alternative theory of Padget (1944) is more acceptable. This suggests that aneurysms form at the sites of temporary embryonic arteries that have failed to undergo complete involution, and accounts for those aneurysms that do not apparently arise at bifurcations. These two theories may not be as incompatible as they at first appear, and in either case it seems likely that the actual aneurysm itself is a product of time.

There must also be complicated and scantily understood rheological factors concerned in the production of what may be conveniently considered as an area of "structural fatigue", and in the mechanics of the final stress that results in rupture—or, as some prefer to consider it, the gentler process of leaking or extravasation of blood. Such extravasation has been observed microscopically to have dissected the walls of aneurysm and artery in some cases. Coughing and straining figure sufficiently often, as initiating factors, in the histories of cases of subarachnoid haemorrhage for it to be impossible to disregard their possible relevance; but, in the majority of cases, the rupture is apparently more truly spontaneous. Hypertension does not seem to be appreciably more frequent in cases of ruptured aneurysm (Falconer, 1954). The site of rupture is usually the fundus of the aneurysm, but it is important, from the therapeutic standpoint, to note that it may sometimes be at the base.

In patients who survive a rupture, adhesions are formed in the immediate neighbourhood of the aneurysm, which thus becomes sealed off from the subarachnoid space. Subsequent haemorrhage, therefore, is often directly into the brain (Williams and his colleagues, 1955).

Incidence and age

It has been estimated that "berry" aneurysms of the cerebral arteries are present in 0.5–1.0 per cent of the general population, but these are necropsy figures which cover both ruptured aneurysms and those found incidentally.

The average age at which rupture occurs is about 45 years, and 80 per cent of cases are over 30 years of age (Falconer, 1954).

Sites

The majority of aneurysms are on, or close to, the anterior part of the circle of Willis, and the small proportion (about 15 per cent or less) that are in relation to the vertebral and basilar arteries are at present of surgical interest only rarely, and then as problems in differential diagnosis, when they are large enough to simulate neoplasms of the brain stem or cerebello-pontine angle. Peripherally situated aneurysms are rare.

In clinical practice it is convenient to recognize three main situations, each with some therapeutic significance. Aneurysms at the termination of the internal carotid artery, or in relation to its immediately adjacent branches, commonly the posterior communicating artery (Figs. 1 and 2), form the largest group (about 50 per cent); those related to the anterior cerebral or its communicating artery (rather more than 20 per cent) are next in frequency (Fig. 3), followed closely by those of the middle cerebral artery, usually at its first division (Fig. 4). In necropsy series the proportion of anterior communicating aneurysms is usually higher. This may be confirmation of their particular reputation for deadliness, or because they are sometimes difficult to see in arteriograms.

Aneurysms are multiple in 10 per cent or more of cases.



FIG. 1.—A left carotid arteriogram showing a small aneurysm, in a man aged 45, at the origin of the posterior communicating artery. The lesion had ruptured earlier; treatment was by common carotid artery ligation

Size

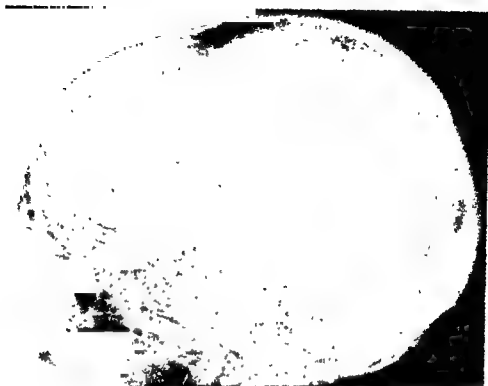
Nearly all Falconer's (1954) 148 consecutive aneurysms were less than 1.5 centimetres in diameter. The large aneurysms which produce focal pressure signs and radiographic changes of local bony erosion are rare; these enlarge slowly, lamellated thrombosis tends to occur within them, and their walls may thus thicken and later calcify (Fig 5). They seem less liable to rupture than the little aneurysms, but may do so. They were described at a time before routine arteriography had shown that the great majority of ruptured aneurysms were small and rarely produced focal signs other than a third cranial nerve palsy. A small aneurysm is shown in Fig. 1, but they may rupture when even smaller than this.

Shape

While, typically, they are berry-like, lobulated aneurysms (Fig 3) may be seen, and also dumb-bell-shaped ones which may be due to the formation of a false aneurysmal sac following a rupture that has been well localized.

Angiomatous malformations (synonym—angiomas)

These lesions (illustrated in Figs. 6-8 and 11-14) may be considered second in surgical importance, although, as a cause of haemorrhage, they are encountered very much less frequently than aneurysms. They tend to rupture earlier in life, and are probably the chief cause of cerebral apoplexy in childhood (Figs. 11 and 12).



(a)



(b)



(c)

They are not neoplasms, but developmental anomalies (vascular "hamartomas") that act as areas of circulatory perversion, for almost all of them are seen on angiography to have *abnormal arteriovenous connexions*. The total lesion varies in size from a small "telangiectasis" to a huge "serpentine" in "racemose angioma" (Figs. 6 and 7). The well-known physiological effects of arteriovenous fistulae on the vessels concerned, and on the circulation in general, vary according to the size and duration of the shunts; but the general circulatory effects are much less frequently seen than in the similar anomalies that are found, more rarely, in the limbs.

They may be situated on the surface or deeply in the brain, sometimes projecting into the ventricular cavities. Thus, they are more liable to bleed into the brain substance (Figs. 6, 11 and 12) or ventricle than directly into the subarachnoid space. It is a general impression that this form of haemorrhage is less severe than that from an aneurysm—indeed, the vessel concerned is likely to be smaller. It is also believed that it is the smaller malformations that are the more likely to rupture (Figs. 11 and 12).

Haemorrhage from unknown cause

In approximately 20 per cent of clinical cases of spontaneous intracranial haemorrhage (other than those due to hypertension), no cause can be found, even when bilateral carotid angiography has been performed. A subsequent autopsy may reveal an aneurysm on the vertebral-basilar system, or sometimes one anteriorly that has not shown on the carotid arteriograms. An aneurysm may occasionally clot after rupturing; and it is believed also that small angiomatous malformations may sometimes destroy themselves by haemorrhage, for many of these idiopathic apoplexies attack young people.

Hypertensive cerebro-vascular disease

This is the commonest single cause of spontaneous haemorrhage; it is also by far the most lethal. Fifty per cent of Professor Dorothy Russell's (1954) necropsy cases were in this group (the majority suffered from "benign" hypertension), in contrast to 20 per cent due to aneurysms and 4.5 per cent which had angiomatous malformations. The well-known descriptions of this classical apoplexy will not be re-stated here.

Surgery has usually little to offer. The stroke is by no means always fatal; spontaneous recovery to a variable degree may take place, and this may occasionally be assisted beneficially by the surgical evacuation of a clot that is refractory to the natural process of absorption. The patient may then survive a year or two before there is a similar, or an associated, catastrophe that is usually fatal.

Unusual causes

Blood diseases, notably *acute leukaemia*, head this list, and are followed in order of frequency by *intracranial neoplasms*. In spite of common belief to the contrary, haemorrhage from a brain tumour as a clinical event is unusual; and it is rare even for that true vascular neoplasm, the cerebellar haemangioblastoma, to bleed.

A tuberculoma, or the small tubercles in tuberculous meningitis, may occasionally erode blood vessels and cause haemorrhage; and polyarteritis nodosa is probably one of the rarest causes, not having been encountered at all in Dorothy Russell's (1954) 461 necropsies of cases of spontaneous intracranial haemorrhage.

CLINICAL DIAGNOSIS

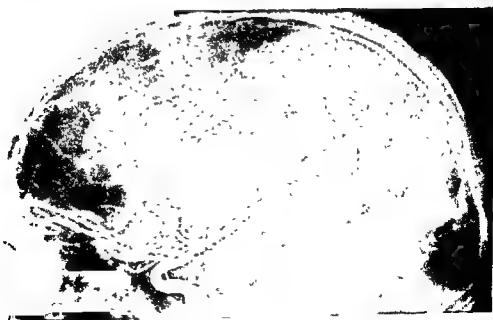
Diagnosis of intracranial haemorrhage

Typically, there is severe headache of abrupt onset, vomiting is common, and there is usually, but not always, loss of consciousness, sometimes an epileptic fit occurs.

A confirmatory *lumbar puncture* should always be performed; the pressure is



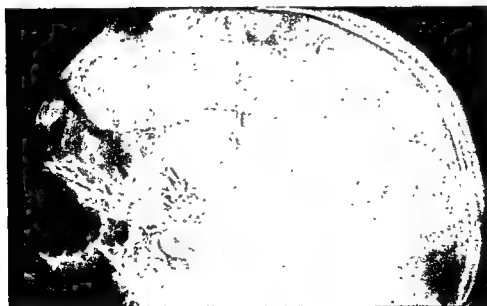
(a)



(b)



(c)



(d)

FIG. 3—A multilocular aneurysm of the anterior communicating artery, filled in a left ventral arteriogram: (c) antero-posterior and (d) lateral views before operation.



(a)



(b)

FIG. 4—A right middle cerebral artery aneurysm which caused a fatal subarachnoid haemorrhage in a man aged 26. Note, in the antero-posterior view (a), the gross irregularity of the first part of the middle cerebral artery (between the arrows) due to spasm. At autopsy, this portion of the artery was of normal, regular calibre, but was stained yellow by blood pigment.

recorded, and the fluid in the manometer withdrawn so that the degree of blood-staining can be ascertained. The pressure is usually high, but on rare occasions will be low or even negative, and the fluid may need to be aspirated. In subarachnoid haemorrhage, the appearance of blood in the lumbar sac is sometimes delayed for a few hours; and in strictly intracerebral haemorrhage, it may not be found at all. Within a few days, or earlier, the supernatant fluid becomes yellow and, according to the size of the haemorrhage, will persist so for about 2 weeks or more; often until well after the clinical signs have disappeared—an important diagnostic point, especially in mild cases.

Subarachnoid haemorrhage

When the leptomeninges are primarily affected, neck stiffness and a positive Kernig sign usually supervene, although sometimes not for several hours. The patient is frequently confused, and may complain bitterly of pain in the head and neck. The pupils will be variable, the tendon reflexes usually depressed, and both plantar responses are often extensor. There are, in fact, typically no focal neurological signs.

There is usually some fever for a day or two, and the urine may initially contain both albumen and sugar, which clear later. Sometimes, sciatic pain occurs, presumably as an irritative effect of the blood that has sedimented in the lumbar sac.

Intracerebral haemorrhage

Here, there will often be neurological signs appropriate to the area of the brain involved. The frontal and temporal lobes are most commonly affected by ruptured aneurysms, but when in the former site a clot may give no obvious signs unless it is placed sufficiently far back to induce a hemiparesis. A "homonymous" hemianopia or upper quadrant visual field defect should be specially sought as evidence of a haemorrhage within the temporal lobe. Bleeding may, of course, be both intracerebral and subarachnoid.

Occasionally, a spontaneous intracerebral haemorrhage will proceed insidiously and mimic completely a cerebral tumour. More commonly, it remains concealed behind the more dramatic picture of subarachnoid bleeding.

Diagnosis of the causative lesion

Aneurysms

Headache does not usually precede rupture, but may do so for some days; it is then often situated in one frontal region or in relation to the eye. The aneurysm otherwise gives little clinical evidence of its presence or its situation unless it is a large one, or is situated in relation to the oculomotor nerve, a palsy of which is a reliable localizing sign. With ruptured anterior communicating artery aneurysms, a peculiar type of stupor may be seen, in which there is a remarkable slowing of the responses to questions, commands and painful stimuli. This torpor may be an incomplete version of "akinetic mutism", which may also occur. With it, unilateral or bilateral grasp reflexes may be observed.

Examination of the fundus oculi may disclose a variety of retinal haemorrhages, especially if an aneurysm has ruptured close to the optic nerve sheath; in particular, there may be seen the large subhyaloid type. A unilateral subhyaloid haemorrhage often indicates that the ruptured aneurysm is on that side. A hemiparesis, however, is not a reliable lateralizing sign, for it is as often on the same side as contralateral to the lesion (Falconer, 1951).

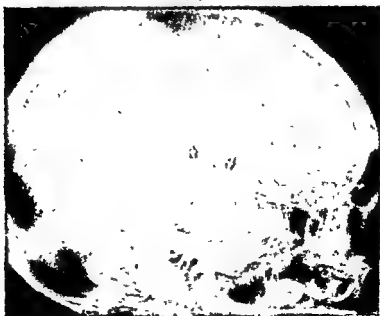
The uncommon, large aneurysms, which seem less liable to rupture, may cause focal neurological and radiological (*see p. 16*) signs peculiar to their localities; and readers may wish to read Meadows's (1951) excellent review, and Jefferson's classical papers on those that involve the optic nerves, chiasm and tracts (1937), and on the



(a)



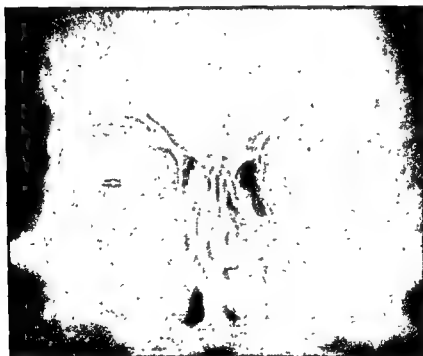
(b)



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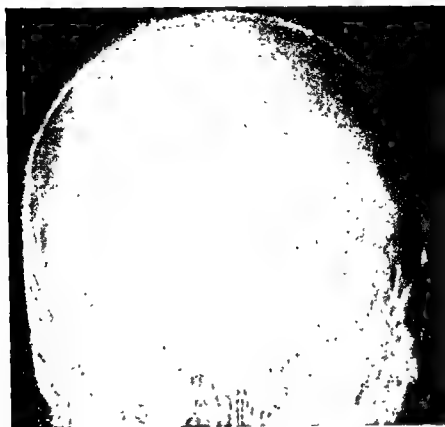
(d)



(e)

FIG. 1. (d) Lateral view. (e) Anteroposterior view.

pain in the first division of the right trigeminal nerve, and dementia. The aneurysm had never ruptured.



(a)

Cerebral embolism

This produces usually an even more abrupt stroke than does haemorrhage, but almost always, is there evidence of heart disease, most frequently affecting the mitral valve.

Thrombosis

Here, the effects are typically less rapid, and also less dramatic, unless an area of great strategic importance (such as that of the posterior inferior cerebellar artery) is involved. But cerebral thrombosis is a clinical diagnosis that is now less readily accepted, because small, leaking intracerebral haemorrhages may be quite mild in their effects, and the blood may not reach the lumbar sac at all—or not in a quantity acceptable for a firm opinion that it is other than a result of the puncture. Moreover, the time relations that, it is often taught, distinguish between embolism, haemorrhage and thrombosis are of limited validity. It is also believed that cerebral infarction can occur from circulatory insufficiency without thrombosis in areas where the arteries are narrowed by organic changes or spasm.



(c)

FIG 7—An extensive intracerebral haemorrhage in the cerebral hemisphere that is fed by

... aged 60, who has had migraine for 40 years and epilepsy for more than 20

That a fit has occurred may be suspected afterwards, when the patient has returned fairly rapidly to normal and the cerebro-spinal fluid is clear. Headache may, however, persist for some hours. A bitten tongue, a past history of fits, and an electroencephalogram showing characteristic changes may be found; but it should be remembered that a fit sometimes accompanies the onset of a haemorrhage. A Stokes-Adams attack may cause rapid loss of consciousness and convulsions.

"Ophthalmoplegic migraine"
This strange affliction produces headache and a temporary third cranial nerve palsy. The same picture may be caused by a supraclinoid aneurysm enlarging suddenly or affecting the oculomotor nerve in some way other than by actually rupturing. No organic abnormality is seen at carotid angiography, and there may have been previous attacks, often dating from childhood.

Acute meningitis—Acute meningitis sometimes fulminates, but lumbar puncture yields purulent instead of bloody fluid.

Intracranial tumour.—This may cause acute headache due to a temporary exacerbation of intracranial pressure, and there may also be neck stiffness associated with descent of the brain stem, particularly in tumours of the posterior cranial fossa. The history and neurological examination will usually establish the diagnosis, but it will be unwise to perform lumbar puncture.

It will thus be seen that, except in the case of tumour, the question of differential diagnosis is largely answered by lumbar puncture.

Plain x-rays

RADIOLOGICAL DIAGNOSIS

The skull should always be examined radiologically for calcification in the wall of an aneurysm (Fig. 5) or in an angiomatic malformation (Fig. 8), but these signs are uncommon in cases of haemorrhage. If the pineal body is calcified, it may show some shift laterally indicating a sizeable clot.

Large aneurysms, particularly those originating in the cavernous sinus ("sub-clinoid"), may cause local bony erosion of the lesser sphenoidal wing (Fig. 5e), especially in the region of the superior orbital fissure and the adjacent part of the optic foramen, and of the anterior clinoid process itself.

Angiography

By means of angiography, precision is achieved in the diagnosis of aneurysms and angiomatic malformations, the localized haematomas they may produce, and of the spastic changes that often occur in the adjacent arteries during the acute stage of the illness. This method is therefore responsible to a large degree for the increased surgical interest in these lesions and for almost all that is rational in their present-day management.

The technique will not be described; the percutaneous method of puncturing one of the carotid arteries in the neck has now almost entirely superseded the tiresome "open" method, and, in skilled hands, it is a reasonably safe procedure.

Provided facilities are available, all cases of spontaneous intracranial haemorrhage that are not clearly of hypertensive origin should be investigated by this method. If there is a history of asthma or other allergic states, some prefer to use Thorotrast instead of one of the diiodone preparations, but, as the long-term effects of the radioactivity of the former may be undesirable, its use is usually restricted to older patients, and the need for it is infrequent.

When to perform angiography

Until the cause of the haemorrhage is known, and the lesion clearly delineated, no specific treatment can be employed, it was this reasoning that led to the practice of



Fig 8 —The arrow indicates faint, mottled calcification in a small part only of a large right frontal angiomatous malformation in a man who started to have generalized epileptic fits at the age of 19.

doing this investigation as soon after the haemorrhage as possible. However, such complications as may attend it, for example, a general worsening of the condition of a patient who is already seriously ill or the appearance of fresh abnormalities such as hemiparesis, are understandably greater if an aneurysm is still bleeding; and since few neurosurgeons now advocate very early operation, it has become usual for angiography to be carried out about a week or even longer after the onset of haemorrhage.

The likely side is first examined, and, if this does not show an abnormality, the other internal carotid is punctured, but it is better not to do this on the same day. In any case, both sides are usually examined since there may be bilateral aneurysms. The standard views are antero-posterior and lateral, and an oblique one (Fig. 2c) is usually necessary in order to exclude an aneurysm that is obscured by adjacent vessels. Phlebograms are taken, at approximately 2 and 6 seconds after the arteriographic phase, in order to show the later venous drainage of any angiomatous malformation. If an aneurysm is shown, the opposite common carotid artery is compressed and another antero-posterior arteriogram taken in order to demonstrate the presence or absence of a free anastomosis across the anterior communicating artery (Fig. 2b).

Vertebral angiography.—This is not done routinely, but may be required for a specific purpose, such as the demonstration of any contribution that the branches of the basilar artery may be making to an angiomatous malformation (Fig. 7c), and thus to help in the assessment of its operability. Aneurysms of the vertebral-basilar system are uncommon and only rarely operable, but a few of the even rarer angiomatous malformations of the cerebellum may sometimes be amenable to surgery (Logue and Monckton, 1954).

Considerable experience is needed for the recognition of some small aneurysms, and the arteriograms reproduced in Figs 1–5 all show obvious ones. A common mistake is for the novice to interpret as an aneurysm the dense and well-defined circular shadow of an artery seen end-on. An aneurysm is not usually so regularly circular, and never so relatively opaque unless superimposed on other arteries.

PART I—ORIGINAL ARTICLES

PROGNOSIS

It is always difficult to tell the natural prognosis of an individual case: a mild initial haemorrhage may be followed shortly by a fatal one, and a severely ill patient may recover completely. The best possible statistical series, when it appears, will give little comfort to any patient's relatives.

Aneurysms

The immediate prognosis

For a patient bleeding for the first time from a ruptured aneurysm, the outlook is to some extent adversely influenced by three chief factors: (1) deep coma which usually implies either a severe haemorrhage or that a strategic part of the brain is involved; (2) a patient over 50 years of age; and (3) by any pre-existing hypertension. Such hypertension is probably not significantly more frequent in cases of ruptured aneurysm, but a temporary increase in the blood pressure may occur secondarily to the haemorrhage itself. Persistence of orbito-frontal pain is often a warning that further bleeding will occur.

It appears that rather less than 50 per cent of patients die during their first illness from a ruptured aneurysm. Over this period, there may be several episodes of bleeding, but probably about two-thirds of this group are out of the reach of effective surgery, except in a few fortunate cases.

Late prognosis

It is not yet certain what proportion of those who survive the first illness die subsequently from recurrent haemorrhage, or how long this takes to happen. Probably 20 per cent do so, but it may be considerably more. About half these deaths occur within the subsequent 6 months, and, for some reason that is not clear, women seem at least twice as liable as men to die from recurrent haemorrhage (Walton, 1952).

It may be inferred from these figures that there must be a death-rate significant—less than 20 per cent in patients who have been operated upon—including those who bleed fatally later despite an operation—if we are to believe that a prophylactic operation is an improvement upon natural processes. The remarkably low mortality, reported by Norlén and Olivecrona (1953), of only 2 deaths in 63 operations for direct attacks on aneurysms in a 2-year period, has been a considerable stimulus to this type of surgery. Some of these patients may yet suffer further episodes of bleeding, but it is hard to believe that such skilful surgery has not something important to offer those who have survived a haemorrhage (such were those selected), each of whom would otherwise appear to have at least a one-in-five chance of a premature death.

Morbidity

Ill-effects, short of death, occur in about one-third of those surviving their first haemorrhage from an aneurysm, but they may also follow a prophylactic operation. The relative dangers with the differently sited aneurysms have not yet been satisfactorily assessed. The anterior communicating artery lesions have an especially evil reputation for producing dementia, while those of the middle cerebral artery are liable to result in hemiplegia with, or without, dysphasia, from which recovery may be incomplete. Diplopia from a partially recovered third-nerve palsy may persist after rupture of an aneurysm near the carotid termination, and it is one of Nature's paradoxes that this should not be possible until some recovery from the ptosis allows the lid to open. Other possible sequelae include epilepsy and headache, and psychological disturbances, both organic and due to anxiety, which are similar to those that may follow severe head injuries, and which may be aggravated by advising or allowing needless invalidism.

Angiomatous malformations

When these lesions bleed, the prognosis both for immediate and later survival appears to be considerably better than is the case with a ruptured aneurysm. Many

examples have been described of long periods (20 years or more) between bouts of haemorrhage, and patients are known who have weathered up to twelve episodes.

If the causative lesion can be completely removed, the prognosis as regards haemorrhage (but not necessarily epilepsy, on account of the scar that remains) should be good, although one or two cases have been met in which a fatal, recurrent haemorrhage has occurred in spite of what was thought to have been a radical removal.

It has been suggested that radiotherapy may improve the long-term prospects for patients with inoperable lesions (Potter, 1955).

Morbidity

Paralytic and mental changes may result also from rupture of angiomatous malformations, depending somewhat on their site and on the severity of the haemorrhage. Again, the lesser fury of these bleeding episodes is a favourable factor. Epilepsy is often a natural accompaniment of these lesions before they rupture, but it may start only after a haemorrhage (or an operation).

TREATMENT OF INTRACRANIAL ANEURYSMS

General management

The immediate treatment of a case of intracranial haemorrhage will usually be that of a comatose patient, and this has been described in detail elsewhere with reference to head injuries (Botterell, 1948a). The maintenance of a free airway is perhaps the most important point to stress. It is as well to empty the rectum with a plain enema soon after admission; and to give liquid paraffin, $\frac{1}{2}$ fluid ounce, twice daily in order to prevent constipation and the necessity for any straining at stool later.

Lumbar puncture is probably best avoided after the initial diagnostic one unless there is a good indication, such as the desire to know whether haemorrhage has recurred. Its overall therapeutic value is doubtful, although it may relieve headache temporarily. It may, however, be dangerous: the risk of precipitating renewed bleeding is probably small; but sudden or delayed death from medullary or mesencephalic "coning" may sometimes follow, especially if there is a large intracerebral clot, the presence of which may not be recognized in the earlier stages of the illness.

Headache may be agonizing, and aspirin-phenacetin-codeine mixtures by mouth or rectum often give little relief, but rectal infusions of 50 per cent magnesium sulphate may be helpful. Before resorting to morphine or pethidine, it should be realized that the added vomiting that these drugs are liable to encourage may induce further haemorrhage. Heroin does not have this great disadvantage to anything like the same degree.

Any essential or "malignant" hypertension should probably be treated with the appropriate "hypotensive" drugs, unless the patient is elderly. In theory, it is as well to wait for about 2 weeks before doing this for fear of risking further insufficiency of blood to those areas whose nutrient arteries may be in spasm.

Following a subarachnoid haemorrhage, whether or not there has been an operation, a period of about a month in bed should be observed, and the patient's return to normal activity gradual. It must be admitted that the rationale for this is somewhat insecure; for just what it is that imposes a strain on the aneurysm is not clear. As with head injury cases, it is important to be sympathetic, but not to encourage anything that might result in permanent invalidism.

When to operate

As has been said earlier, the results of any operation (carotid ligation or direct attack) that may be undertaken during the early stages of the illness are probably no better than those of expectant treatment. The chief reason for this is now believed by many to be the abnormal propensity towards spasm that exists in the cerebral arteries

PART I—ORIGINAL ARTICLES

in the vicinity of a recently ruptured aneurysm. The resulting irregularity of the arterial lumen has been demonstrated clearly in arteriograms that have been performed early (Fig. 4), and this radiological picture is an extremely uncommon one on other occasions. Arterial spasm has also been described by those who have observed it directly at operation; and the evidence of the case illustrated in Fig. 4 suggests that it may well be a direct effect of the extravasated blood, or of its breakdown products on the smooth muscle. If this is so, the sympathetic nervous system is unlikely to be of much relevance.

Operation, therefore, is now often postponed until about 2 or 3 weeks after the onset of haemorrhage. Assessing the optimum time may be extremely difficult, since renewed and fatal haemorrhage may supervene while one is awaiting further improvement in the patient. Recovery from the mental disturbance usually indicates that it is reasonably safe to proceed with operation. Cases must, of course, be judged individually, and it may sometimes be felt that an operation ought to be performed during the early stages of a desperate case that seems certain to end fatally unless the bleeding can be controlled. In those few cases where the clinical evidence is sufficient to localize the lesion, it is possible to ligate a carotid artery or evacuate a temporal lobe clot without prior resort to angiography, but this is not usually desirable. Patients whose lives are endangered by localized but expanding haematomas demand special consideration which is accorded at the end of this chapter.

Carotid artery ligation in the neck

Uses

This Hunterian ligation is still, for many surgeons, the standard surgical procedure for most aneurysms of the *internal carotid artery* (especially the *infracaloid lesions*) and for those in the immediate neighbourhood of its termination. It is less common used to cause a fall in pressure in aneurysms that are situated more peripherally on the carotid tree, such as those on the *middle cerebral artery*. An anterior communicating artery aneurysm, however, usually enjoys a free and close communication with either carotid and does not seem to be very suitable for this type of treatment, although a similar principle is employed by Logue when he clips the anterior cerebral artery proximally (*vide infra*).

Apart from the occurrence of haemorrhage, it should be mentioned also that carotid ligation is an excellent operation for those unruptured carotid aneurysms that cause pain, bony erosion and disturbance to local structures.

The efficacy of carotid ligation

Those with experience of this operation (for example, Jefferson, 1952; Johnson, 1952) believe that it reduces the chances of further haemorrhage, but no one accepts that the protection is likely to be absolute. The degree of prophylaxis is still unknown, but there is satisfactory evidence that the pressure falls distally in the carotid system, and that this fall is maintained for a period that is considered sufficiently long to be useful (Bakay and Sweet, 1953). Even an aneurysm at the first bifurcation of the middle cerebral artery may be observed at operation to reduce or cease its pulsation when the common carotid artery is occluded distally in the neck. Cure by thrombosis is known to have followed ligation, but the proportion of cases in which this fortunate event happens is again unknown.

Dangers and precautions

Sixteen years ago, Schorstein (1940) showed that hemiplegia and death occur very much more frequently if, at the time of carotid ligation, the patient is already ill as the result of recent haemorrhage. The importance of the timing of this operation has been insufficiently appreciated by those who have emphasized the dangers of the operation *per se*. Surrounding the whole subject of carotid ligation there is also a

vague atmosphere of disrepute which is possibly a relic of pre-Listerian days, when the procedure was used more heroically for haemorrhage that was often secondary to sepsis, or in connexion with severe operations for malignant conditions. The operation is a relatively safe one if undertaken after the initial two-week or three-week period, by which time the patient is usually reasonably well.

Immediate hemiplegia.—However, some individuals, owing probably to an anomalous circle of Willis, are immediately intolerant of the procedure. In all cases, therefore, a trial period of about 30 minutes should be observed during which a Crile's clamp is fully applied to the artery, and the patient tested carefully at intervals for evidence of a developing hemiplegia. If this occurs, it is unsafe to ligate. Digital compression of the common carotid artery against Chassaignac's (carotid) tubercle is unreliable in ensuring complete occlusion. Some American surgeons practise this pre-operatively for periods of increasing duration in the hope that the collateral circulation may thereby be the better prepared for its task. The method may also be tried in order to prepare for a second attempt a patient who is intolerant initially.

Delayed hemiplegia.—This is the dreaded complication in a few cases. It is largely unpredictable and occurs some hours or days after operation. Its mechanism is disputed, for most cases do not die and reveal for certain the cause. Embolism and thrombosis have been popular explanations, but it is known that cerebral infarction may occur without any obvious organic occlusion of the arteries; it is felt by many that such factors as arterial spasm and a fall in the systemic blood pressure may sometimes be the cause, either individually or in combination with the relative deprivation of blood supply already effected by the ligation.

Pre-operative angiographic evidence of a good anastomosis across the anterior communicating artery (the "cross-circulation test") may be comforting, but it cannot be relied upon to mean that all will be well; conversely, it is possible to ligate the common carotid artery without ill-effect when there is apparently no anterior communicating artery at all—as judged by this test. The electroencephalogram is also unhelpful in predicting complications (Potter and Taylor, 1955). Attempts have been made to formulate rules for ligation according to the degree of the fall in intra-arterial pressure when this is measured distal to the clamp, but no notable conclusions have yet emerged. Measures such as the plication of the artery wall and the use of metal or fascial bands have been designed to prevent damage to the carotid intima, which, the protagonists of these methods believe, favours the formation of a loose or spreading thrombus. Few surgeons believe that block or section of the cervical sympathetic chain diminishes the incidence of complications; and the suggestion that anticoagulant drugs should be used finds no favour with those who feel that the sound healing of the hole in the aneurysm is the primary objective.

If the hemiplegia occurs early and is recognized promptly or before it is complete, and if the ligatures can be removed with the utmost rapidity, then recovery may occur with astonishing suddenness. It is for this reason that division of the artery after ligation is not advised. The ligatures should not of course be undone if there is already thrombosis beyond them, and a strong warning must be given that disastrous effects may attend the flooding of an already infarcted area of brain with a fresh torrent of arterial blood. When in doubt, it is better to hope for spontaneous recovery, and to some extent this will frequently occur. It is wise to keep the foot of the bed raised post-operatively, for the upright posture has several times been noted to have induced or aggravated a hemiplegia, which improved when the patient lay down.

Common versus internal carotid ligation

Two opposing objects are in view when carotid ligation is under consideration in these cases. On the one hand, the stresses operating upon the aneurysm need to be reduced as much as possible, and on the other, an adequate supply of blood must be preserved for the brain.

Ligation of the common artery is generally considered safer than that of the internal carotid. Internal carotid ligation is nearer to the aneurysm, however, and cuts out any contribution from the external carotid. A compromise is sometime effected by tying first the common carotid and, a week or two later, the internal hoping for some collateral circulation development meanwhile.

However, since the degree of protection seems as much in doubt in one method as in another, common carotid ligation alone may be recommended to those who wish for arbitration in this matter.

The technique of common carotid ligation

No special merit is claimed for this particular procedure, except that it is straight forward and has given results that compare favourably with those of more elaborate and time-consuming techniques.

Narcosis with Omnopon, $\frac{1}{2}$ grain, Scopolamine, $\frac{1}{150}$ grain, and Seconal, $1\frac{1}{2}$ –3 grains given three-quarters of an hour beforehand, makes the operation an undisturbing experience for the patient, who can usually co-operate satisfactorily during the important neurological examinations, the first of which should be carried out before the operation is started. Local analgesia ($\frac{1}{2}$ or 1 per cent Xylocaine) should be without adrenaline, which may cause a rise in blood pressure dangerous to the integrity of the aneurysm.

A "half-collar" incision is made in a convenient skin crease. The artery is exposed conventionally, either above or below the omohyoid, and a length of 2–3 centimetres is cleared within its sheath. Two strong, waxed, twisted-silk ligatures are placed in position, above and below, but are not tied. The rubber-covered Crile clamp is then screwed on between the ligatures, and the 30-minute period of trial occlusion begins. If no evidence of a hemiplegia occurs (equivocal plantar responses and other doubtful signs should be disregarded), the two ligatures are tied before the clamp is removed. This leaves a collapsed length of artery of about a centimetre between the two ligatures, whose ends are left conveniently long in case their rapid removal becomes necessary later. This spaced, double ligation is a precaution against the reconstitution of the arterial lumen that sometimes follows a single ligature. The platysma is closed with catgut, and the skin with Michel's clips.

It should be added that this operation is not always a straightforward one, particularly in patients with short, thick necks. Recent carotid arteriography by percutaneous puncture in the vicinity may have caused some extravasation of blood, making the identification of the deeper structures a little more difficult; and the artery itself is frequently stained yellow within its sheath. In the early days of arteriography by "open" operation, carotid ligation was usually performed at the same time immediately after the aneurysm had been demonstrated radiologically.

structures, particularly the internal jugular vein, may have become adherent to the artery and its sheath.

Carotid ligation for certain intracranial aneurysms is by no means outmoded; it has the great advantage of being within the competence of all surgeons, and is therefore likely to die hard. The difficulties that arise in connexion with the operation, however, should be appreciated, and they have been discussed in detail. The operations that follow are of a more specialized nature, and will be dealt with more briefly.

Direct attack on the aneurysm

The information afforded by carotid arteriography, the encouraging operation results already mentioned, the coming of controlled arterial hypotension, some misgivings about the effectiveness of carotid ligation, and, above all perhaps, the

feeling that the cure of such a treacherous lesion is at least possible—all have combined to produce an access of enthusiasm for direct operations on the aneurysm itself.

Indications for direct attack cannot yet be given, as the decision often depends on the individual surgeon's experience and estimation of his ability to deal with any particular aneurysm. It is felt that the patient or his relatives, provided they are adequately intelligent, should share with the physician and surgeon some of the responsibility for what is to be done in a difficult case. The issue is likely to be the choice between the relative safety, but uncertain value, of carotid ligation, and the more dangerous, direct attack that offers a better chance of a lasting cure; and if carotid ligation is preferred, who is yet to say that this is wrong? It is unfair, at present, to expect a surgeon always to be able to give the dogmatic advice that is so often possible in other surgical problems; although in most cases he will have definite guidance to offer

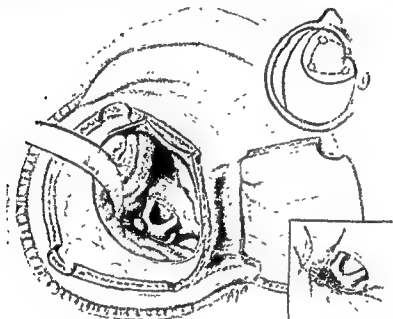


FIG 9—The exposure of an aneurysm of the anterior communicating artery, which was wrapped with muscle (inset)

Routes of exploration

The operation is usually exploratory, for the arteriogram is likely only to suggest what it may be possible to accomplish when the aneurysm is reached

Aneurysms on and near the anterior communicating artery are usually explored; those of the middle cerebral artery often so (particularly when the cerebral hemisphere is the non-dominant one), but only some of those around the carotid termination are deemed more suitable for direct attack than for carotid ligation. The individual surgeon's selection is encountered particularly in this last group

Anterior communicating artery.—This artery is approached through a frontal flap as for a pituitary operation (Fig 9). It is exposed by elevating the frontal lobe (preferably the right in a right-handed patient), entering the chiasmatic cistern, tearing gently through the pia-arachnoid, and, if necessary, sucking away a little brain in the immediate vicinity of the aneurysm. When the aneurysm projects upwards and backwards, it may be easier to approach from below. The aneurysm is then exposed and the anterior communicating artery is ligated. The operation is complicated by the proximity of the corpus callosum and the optic chiasm.

superior cerebral veins, but these complications may also result from the first approach, although they are often only temporary.

Middle cerebral artery.—The artery may be approached by a similar sort of flap, or through a *temporal craniotomy*, which is opened medially along (Fig. 10).

End of the internal carotid artery.—This is situated more medially, and to expose its supraclinoid aneurysms the arachnoid need not be divided until later in the approach. By retracting the pole of the temporal lobe backwards (after dividing the sphenoparietal sinus tributaries), a good view is obtained of the posterior communicating artery and the closely related oculomotor nerve.

Clipping, ligation and "trapping"

Clipping.—Having exposed the aneurysm and its immediately related arteries, it is only then possible to decide what best can be done. Ideally, one hopes for a well-defined, narrow stalk or neck across which a *silver clip* can be applied without damaging or kinking unduly the nearby arteries. Unfortunately, this is not the usual state of affairs, and an aneurysm with a clear "arteriographic neck", that is, when viewed indirectly and from within, may prove an ugly, sessile object when observed directly and externally; and "base" is probably a better term than "neck". However, a clip (or clips) may still be applied to the base, and several, larger and more suitable than those of Cushing, have now been designed to meet various predicaments. The chief object is to exclude the fundus of the sac, for that is the usual, but not invariable, site of rupture.

Ligation.—Sometimes a ligature is more suitable than clips (Fig. 10), but it may be advisable to tighten this only incompletely if it looks like kinking adjacent arteries. During these manoeuvres, carotid compression may assist in reducing the tension

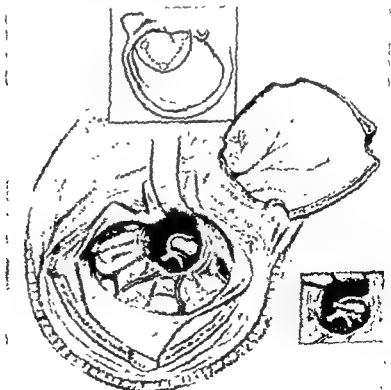


FIG. 10.—Operation on a right middle cerebral artery aneurysm, which was partially ligated at its neck and then wrapped with muscle. One main middle cerebral branch remains unclipped. The patient suffered no disability, and the aneurysm filled in a subsequent arteriogram.

within the aneurysm, or the artery may have been exposed in the neck and surrounded with a tape as a precaution in the case of middle cerebral and internal carotid aneurysms.

"Trapping."—When an aneurysm is "trapped", a clip is applied to the artery on either side of it, but this may only be done if the artery concerned can be occluded with safety. The opportunities are therefore limited.

Rupture during exposure.—If an aneurysm ruptures during its exposure, the outcome is immediately prejudiced. Artificial hypotension has helped to mitigate the immediate difficulties, and prompt carotid occlusion in the neck often decreases the flow. It may be possible to get the collapsed aneurysm and its torrent into the sucker, and then to

his colleagues (1956) have operated early on a few ruptured aneurysms, using hypothermia and occluding temporarily both carotid, and sometimes also both vertebral, arteries; but they are rightly cautious in their initial belief in the advantages that this technique appears to offer.

Spasm during dissection.—In order to counteract any spasm during dissection of the aneurysm, some surgeons apply papaverine sulphate (2.5 per cent) directly to the walls of the neighbouring arteries

Packing with muscle

This is another method of uncertain value. Some employ it in preference to a difficult clipping procedure, especially for anterior communicating artery aneurysms (Fig. 9); whilst others, having reason to doubt its efficacy, regard it as a method of despair, and point to its obvious imperfections. Its advocates believe that it helps to strengthen the wall of the aneurysm by creating an additional fibrous tissue layer. To the suggestion that there are better fibroblastic agents than muscle, it can be replied that too much fibrosis might be harmful to adjacent arteries.

The muscle is usually taken from the temporalis, and is beaten into a flat sheet which is wrapped as completely as possible around the aneurysm. Aneurysms that have been clipped or ligated may be reinforced in this way (Fig. 10).

Clipping the anterior cerebral artery proximally

For aneurysms of the anterior cerebral and its communicating artery, Logue (1955) has tried, and recently reported favourably on, the effect of formally clipping the anterior cerebral artery near its origin, without disturbing the region of the aneurysm. This can only logically be done when the aneurysm fills predominantly from one carotid; but, at the same time, blood must also be able to cross the midline anteriorly. This is but a variant of the problem of the opposing interests of brain nourishment and aneurysm therapy, mentioned already in connexion with carotid ligation. Further time is needed to see whether the operative mortality of 13.5 per cent in 37 cases is an improvement on that resulting from other methods. Logue, who does this operation as early as the patient is conscious, found that in a control series, of 36 cases not operated upon, 44.4 per cent died.

Summary of the treatment of aneurysms

Anterior communicating aneurysms

Direct attack; clipping or ligature if possible, otherwise packing with muscle. Or clipping the anterior cerebral artery proximally.

Middle cerebral aneurysms

Either direct attack or carotid ligation. The latter especially when the speech-dominant side is concerned.

Aneurysms of the internal carotid and near its termination

Carotid ligation. Direct attack in selected cases.

Multiple aneurysms

No surgical treatment unless it is certain which aneurysm has bled; in which case, a direct attack is preferable if this is feasible.

TREATMENT OF ANGIOMATOUS MALFORMATIONS

Considerations regarding operation

The precise information that angiography gives and advances in neurosurgical technique have both stimulated interest also in the surgical excision of many of these lesions. Quite large ones can be removed without mortality—a feat declared by Harvey Cushing less than 30 years ago to be “unthinkable”.

Nevertheless, it must always be asked whether this is the right treatment for an individual case; for, even more remarkable than any surgical results yet published are the numerous instances of long-term survivals, often with little or no disability, that have occurred in patients who have had no treatment other than, say, phenobarbitone for the mitigation of epilepsy. These malformations differ from “berry” aneurysms in the important respect that the haemorrhages that they may produce are usually milder and less of a threat to life. There is not therefore quite the same feeling that a radical approach is necessary, and any prophylactic operation must be correspondingly justified.

It has been suggested that mental deterioration occurs eventually in a large proportion of cases, and that this is a further reason for a preventative operation. This view and its implications have not yet been substantiated and the possibility of dementia will not therefore be introduced here as an influencing factor.

Ideally, we should like to be able to excise a malformation completely, so that there is *no danger of further haemorrhage, no future epilepsy, and no increased physical disability.*

Protection against further haemorrhage

Nothing short of complete excision will guarantee this. Cases, such as that of Gillingham (1953), have been reported where fatal haemorrhage has followed a partial removal. Indeed, this has also been known to happen even after an excision that has apparently been complete. Naked-eye inspection at operation is not therefore infallible; and a few small abnormal vessels may be left behind (Fig. 11).

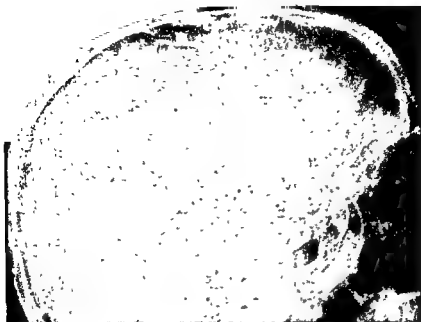
Carotid ligation, or the tying of arteries nearer to the malformation, has no more than a temporary effect before collateral channels open up, and there seems to be no good indication for this procedure, either from a theoretical standpoint or in the light of experience of cases where it has been carried out.

Epilepsy

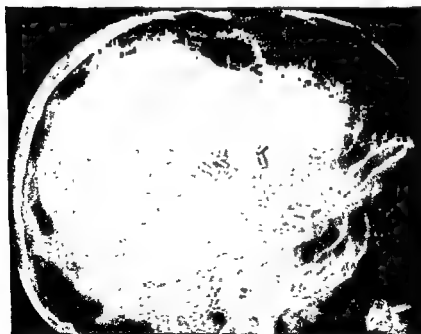
The brain scar that results from an operation may prove to be as epileptogenic as the angiomatic malformation that has been removed—or, sometimes, more so. Epilepsy, *per se*, is not therefore a good indication for excision, unless it is quite disabling and uncontrollable by anticonvulsant drugs—a very unusual circumstance. Moreover, fits which were not present before operation may appear afterwards, and the patient may reasonably consider them to be a poor exchange for an uncertain protection against further haemorrhage. A familial tendency towards epilepsy in these cases should be considered an adverse factor.

Increased physical disability

It is important too that the possibility that the patient may be further disabled (apart from epilepsy) should be weighed most carefully against the estimated protection against further haemorrhage that the operation is likely to achieve. The



(a)



(b)

FIG. 1. (a) Axial CT scan showing a large, hyperdense, crescentic intracranial hemorrhage in the right hemisphere, causing a significant mass effect and midline shift to the left.

patient's work, domestic and financial circumstances, and his adaptability to misfortune must all be evaluated. A left hemiparesis may be a relatively undisturbing and acceptable penalty to one individual, but disastrous to another. It is never justified to risk producing severe aphasia (one of the worst of all human disabilities), and the side of the dominant cerebral hemisphere must always be most carefully established beyond reasonable doubt by inquiring about handedness.

Indications for operation

The foregoing discussion is intended to convey an attitude of caution rather than conservatism towards the surgical treatment of cerebral angiomatous malformations, and to suggest that the indications for operation are largely relative.

Intracerebral clot

A strong indication exists, however, when there is, in relation to the malformation, an intracerebral clot that demands evacuation because it is a space-taking lesion (Fig. 12). At the same operation the causative lesion itself may be removed, if this is possible; for the liability to future epilepsy is, under these circumstances, not likely to be significantly increased by the operation, which is often facilitated by the haemorrhage having to some extent already dissected the malformation.

Small angiomatous malformations

Small angiomatous malformations, where they are easily accessible and, particularly, when they are in an area of relatively low epileptogenic potentiality, should be removed because they seem more liable to bleed than the larger ones.

Increased intracranial pressure

Occasionally, these blood vessel tangles interfere with the freedom of the cerebro-

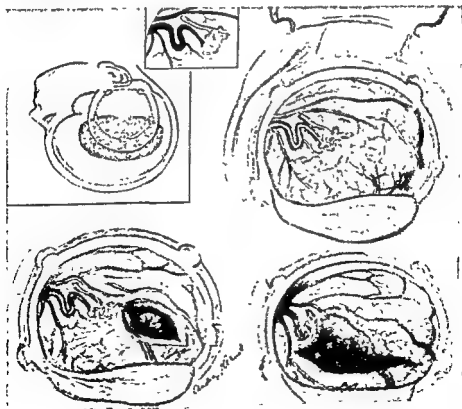


FIG. 12—Excision of a small arteriovenous malformation and evacuation of the associated intracerebral clot. (The same case as in Fig. 11.)

spinal fluid pathways and increased intracranial pressure results. An operation will then be needed, such as Torkildsen's ventriculocisternostomy, whereby an obstruction in the third or fourth ventricle, or in the aqueduct of Sylvius, may be by-passed.

Uncontrollable and disabling epilepsy

The last clear indication, already mentioned as an unusual one, is truly uncontrollable and disabling epilepsy—provided the lesion is not in the "speech area".

Radical excision

The technique will not be described, for it will be carried out *secundum artem*, with modifications according to the particular circumstances of the case. The stages of a typical operation are illustrated simply in Fig 13. Some form of artificial hypotension is commonly employed, plenty of blood should be available and, in the case of a large malformation, it may be wise to expose the internal carotid artery in the neck beforehand as a precaution against a severe haemorrhage in its territory. It is important that the arteries feeding the abnormality should first be clipped or tied, for this has the effect of shrinking the mass. If veins are taken first, engorgement and

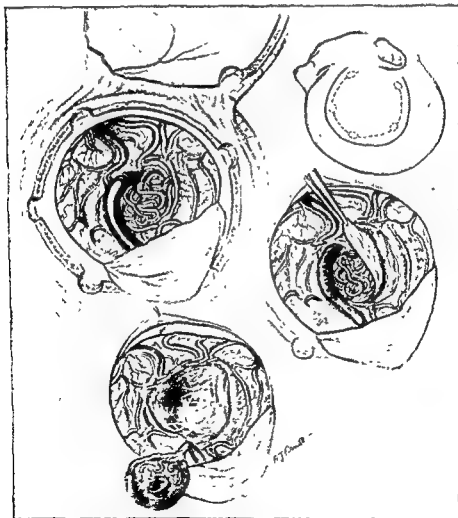


FIG 13—Stages in the excision of a right posterior frontal arteriovenous malformation. The arteriograms are shown in Fig 14.

By courtesy of the Editor of the Annals of the Royal College of Surgeons of England

rupture are likely to occur if the arterial blood, having been shunted, is unable to get away through the veins with its accustomed ease.

It is sometimes very difficult to tell arteries from veins owing to the highly "arterialized" blood that may be seen in the latter. Reference to the angiograms may help considerably, or the effect of temporary occlusion with plain dissecting forceps may be tried.

Radiotherapy and symptomatic treatment

Radiotherapy

This method of treatment, which was popular before radical excision was considered feasible, has now declined in favour for the understandable reasons that it seems only rarely to cure and because the complications of haemorrhage and epilepsy may follow despite its administration. McWhirter and Dott (1955) advise against it. Nevertheless, a recent, long-term, follow-up survey (Potter, 1955) has suggested that it may after all be of some value in protecting against lethal haemorrhage and in reducing subsequent disability. The evidence is not conclusive; but, provided that no harm is done, it seems right to offer any chance that there may be of a better prognosis, and radiotherapy is recommended, therefore, in cases for which radical excision is not considered suitable. It is known that the small cerebral vessels are affected by therapeutic x-ray dosage, and it is therefore not unreasonable to hope that these demonstrably abnormal shunting vessels should be more vulnerable. Such selective thrombosis of these vessels by accurate irradiation would be a theoretically ideal method of treatment, and a suitable technique may yet be evolved. The necessary accurate two-plane localization of the lesions has already been achieved by angiography.

Symptomatic treatment

The regular taking of phenobarbitone will usually control the epilepsy that may complicate these lesions, or keep it within tolerable limits. It may be necessary to add Epanutin, or to substitute one of the newer anticonvulsant drugs; and persistent attempts should be made to find a suitable medicinal regime for a patient whose fits are troublesome, before turning towards an operation that is likely to be dangerous or disabling.

Provided the headaches which may afflict the patient are not due to increased intracranial pressure, some kind of aspirin-phenacetin-codeine mixture or tablet will usually help, but for those that are migraine-like, ergotamine tartrate, either with caffeine (Cafertog) orally or alone by injection, may be required.

INTRACEREBRAL AND SUBDURAL HAEMATOMAS

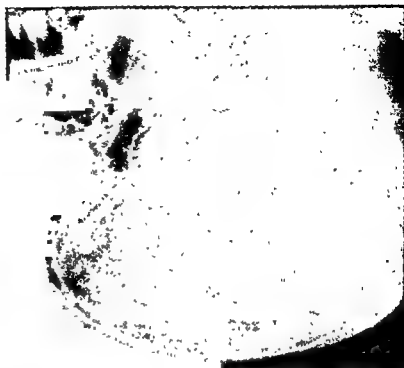
Intracerebral clots

Where non-fatal haemorrhage results from hypertension, or from any cause, the natural process is for liquefaction of the clot to occur, followed slowly by absorption and gliosis, or the formation of a cavity which may communicate with the ventricle (porencephaly). This process may be hastened by surgical evacuation of the haematoma, but it is not certain whether the end result is thereby improved for the patient.

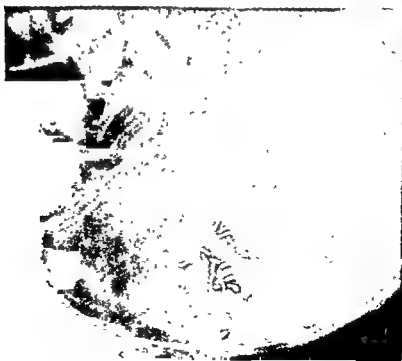
Burr-hole evacuation versus bone-flap craniotomy

Evacuation through a burr-hole may be achieved if the haematoma is liquid, but fluid may re-form. In hypertensive cases there is always an added risk that blind needling may cause further haemorrhage. On the whole, and since there is usually solid clot present, it is generally better to remove the haematoma by means of a formal craniotomy, when an incision is made into a suitable part of the cerebral

INTRACRANIAL HAEMORRHAGE



(a)



cortex, as in Fig. 12, and the clot removed under direct vision. It is remarkable how rapidly the adjacent brain brings together the walls of the cavity to obliterate it.

Subdural haematomas

Apart from those considered elsewhere (Botterell, 1948b) as complications of a known head injury, many subdural haematomas form in the absence of any clear history of trauma, although, one suspects, sometimes this may have been trivial and is forgotten. Occasionally, an aneurysm will rupture into the subdural space, and any other type of intracranial haemorrhage may extend in the same way.

Such haematomas are treated, as are the traumatic ones, by evacuation through two or more burr-holes; or, if they are solid, by turning a flap. At least one burr-hole should always be made on the opposite side, for subdural haematomas, particularly if trauma is the cause, are frequently bilateral.

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MAXILLA-CARCINOMA OF

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INTRODUCTION

Definition

The maxillary framework of the face is a complicated honeycomb of air spaces lined by mucous membrane and supported by bone. Carcinoma of the structures concerned is broadly referred to as cancer of the upper jaw. The tumours may be of many different types and invade from the oral surface of the bones or arise within the nasal sinuses. Occasionally carcinoma arises in contiguous structures and extends into the facial bones. Surgical removal almost always results in disfigurement and is, therefore, approached with reluctance. For these reasons diagnosis and treatment of such growths is often difficult and unsatisfactory. Present methods are better than in the past, but there is still scope for considerable improvement.

Primary growths

Carcinoma of the upper jaw may be divided into two main groups, primary and secondary. The primary group includes those of the antrum, ethmoids, upper alveolus, palate and nasal fossae. Carcinoma of the sphenoidal air sinus is exceptionally rare.

Secondary growths

Secondary invasion of the upper jaw from contiguous structures is encountered when epitheliomas and rodent ulcers of the skin of the face and lip invade the underlying bone, and when growths of the mucous membrane of the cheek, or even tumours of the lower jaw, extend on to the upper alveolus.

Responsibility for treatment

It can readily be understood that the problem is one of considerable complexity and that it is difficult to decide within whose province a particular case should fall. Since many of these epithelial tumours are radio-sensitive, it is natural that the radiotherapist should be very interested in the whole group, especially as he can treat some of them successfully and without disfigurement. The ear, nose and throat surgeon is mainly concerned from the diagnostic and operative side. But the general surgeon, the dental surgeon, the plastic surgeon and the dermatologist may all be concerned (with the maker of prostheses and the cosmetician in the background). Each must know the capabilities and limitations of the others, otherwise the tumours are liable to get out of hand for want of advice from a new quarter.

Surgical ablation may be considered to be a crude method of treatment, but it must be realized that the growths themselves produce the worst deformity of all.

The deformity of untreated tumours

The features become distorted (Fig. 15a and b), pain is often intense; eating, drinking, breathing and even seeing may become difficult; accompanying infection and fistula formation is often associated with a terrible stench and the patient's state becomes one of pitiful disgust, witnessed usually only by his general practitioner—not by those who have failed to cure his tumour. Fear of radical surgery must not, therefore, be allowed to cloud the issue.



(a)



(b)



(c)



(d)

FIG. 15—Carcinoma of antrum, fungating through on to cheek. (a) before radiotherapy; (b) persistent tumour with fistula formation, after radiotherapy; (c) after total excision of right upper jaw; (d) wearing external prosthesis

(By courtesy of the Editor of *Proc. R. Soc. Med.*)

INCIDENCE AND PATHOLOGY

Proportional incidence of primary tumours

Carcinoma of the upper jaw is not rare. The average number of patients with primary jaw tumours attending the Royal Marsden Hospital over the last 25 years has been 15 per annum. Forty per cent have arisen in the antrum, 23 per cent in the nasal fossae, 17 per cent in the ethmoids and 10 per cent each on the upper alveolus and on the palate. The figures, which are approximate, have been supplied by Dr. Lederman and Dr. Dalley who will be analysing them in greater detail. Secondary tumours have been rarer.

Squamous-celled carcinoma

In the antrum, ethmoid and on the upper alveolus 80 per cent have been squamous-celled carcinoma. Columnar-celled carcinoma and others, and those without histological diagnosis, make up the remaining 20 per cent. On the palate the proportion has been slightly lower, there being a greater number of salivary gland carcinomas. In the nasal fossae 75 per cent of epithelial tumours are proved squamous-celled growths and are four times as frequent as malignant melanomas, which present a special problem but which can be considered in the same treatment group.

SPREAD OF THE TUMOURS

Squamous-celled carcinomas spread by local invasion and remain amenable to local treatment for a considerable time. Lymph node metastasis is not common. In antral and ethmoid carcinomas detectable involvement of regional nodes was present in between 15 per cent and 18 per cent of all cases at their first examination. The proportion was rather lower in cases of carcinoma of the palate; somewhat higher, 25 per cent, in cases of carcinoma of the nasal fossae; and higher still, 50 per cent, in cases of carcinoma of the upper alveolus. Generalized metastasis is rare.

Invasion of the maxilla by rodent ulcer is often unexpectedly deep and more extensive than appears from the surface. Once the tumour has broken through a barrier such as the margin of an air sinus, it spreads rapidly in the deeper planes. Radiotherapy seems, on occasions, to drive a rodent ulcer underground.

SYMPTOMS AND-SIGNS

Epithelial growths and ulcers of the skin, cheek, alveolus and palate are obvious by their presence, yet surprising mistakes are sometimes made in confusing oral types of carcinoma with fibrous epulides and with the distortion of soft tissues which occurs in association with chronic infection of the alveoli and palate. Leucoplakia should, of course, be kept under constant observation for any tendency towards neoplastic metaplasia.

The symptoms of the three other types of primary carcinoma of the upper jaw vary slightly (Wilson, 1954). In the case of the antrum the symptoms depend upon which part of the antrum is first involved. Those arising on the inner aspect cause nasal symptoms. Those on the outer surface spread into the cheek and present as an external swelling, sometimes associated with considerable pain. Upward extension of the tumour into the orbit will produce disturbances of vision, and downward growth, distortion of the palate or alveolus. The patients, for example, may complain of nothing more serious than that their dental plate no longer fits properly. In the case of carcinoma of the ethmoid, nasal discharge with bleeding and obstruction are the commonest symptoms. Swelling, pain and eye symptoms occur later. Growths in the nasal fossa usually present with swelling in the nose or nasal obstruction with discharge which may be bloodstained. These symptoms will usually be present before pain develops. Frank epistaxis is the first complaint in only about 6 per cent of the patients. Anosmia and external swelling occur but rarely.

All tumours may give rise to a feeling of fullness and discomfort at the back of the nose which is difficult to define but important to recognize.

DIAGNOSIS

The nature of ulcerating tumours presenting on the oral surface or in the nasal cavity can be discovered easily enough by taking a fragment for microscopical examination. Proper cutting punch biopsy forceps are best for this purpose and obtain the fragment without the need of local analgesia. The sample needs to extend well into the depth of the tumour in order to get a fair picture of its structure. Very often superficial



FIG. 16—Antero-posterior x-ray of maxilla to show an opacity of the left antrum due to carcinoma which is eroding upwards and medially into the nasal cavity and downwards and laterally into the substance of the cheek below the malar bone.

infection modifies the histological appearance and makes pathological interpretation difficult. If a negative or doubtful result is obtained, the test should be repeated. Frequent biopsy of oral swellings will be rewarded by earlier diagnosis of malignancy.

Transillumination of the nasal sinuses is, of course, a simple and essential part of the routine clinical examination of these patients.

Plain x-rays are of great value (Fig. 16), together with tomography, stereoscopic x-rays and other means of demonstrating the shape of air-filled cavities and the erosions of their margins. These methods, however, may not be enough for the diagnosis of the deeper-seated tumours. Needle biopsy occasionally helps, but usually operative exploration is necessary.

PROGNOSIS

Squamous-celled carcinoma of the antrum is generally taken as the yardstick for the assessment of prognosis of carcinoma of the upper jaw. This is the only group in which sufficiently large numbers are at present available for analysis. The results of Lederman, Mill and Dalley (1956) at the Royal Marsden Hospital and Capps and Williams (1950) at St. Bartholomew's, both series covering many years, give between 34 per cent and 35 per cent 5-year recurrence-free survival rates. In other words, little more than one-third of these patients have, in the past, been cured of their disease. In the case of ethmoid tumours the results are somewhat worse and of tumours of the nasal fossa and palate, slightly better. Recently the results have been appreciably improved.

TREATMENT

Maxillary antrum

Radiotherapy succeeded surgery as the most efficient method of treating these tumours at a time when surgery did not have the advantages of good general anaesthesia, blood transfusion or antibiotics. There is no doubt that radiotherapy can give a result

which is well-nigh perfect in a tumour which is very radio-sensitive. Many, however, either do not respond at all or only partially.

Combined surgery and radiotherapy

Surgery is, therefore, combined with radiotherapy as a conjoint method of attack for the following reasons. Without exposing the tumour it is difficult to define the full extent of the growth. Without opening the antrum it is impossible to eradicate the sepsis and sequestra which very often follow irradiation therapy. For the partially radio-sensitive tumours it is necessary to eradicate what remains after such radiotherapy. The last and almost the most important reason is that the cavity from which the tumour is removed must continually be under observation in case a recurrence should develop.

The first planned treatment of antral tumours is, therefore, either surgery followed by radiotherapy or radiotherapy followed by surgery. At organized clinics this combined treatment has begun to yield a 50 per cent 5-year recurrence-free survival rate, the former method, surgery followed by radiotherapy, giving slightly better results than the latter. Radiotherapy alone has given about a 15 per cent 5-year recurrence-free survival rate, but one must remember that the cases included in this group are those who come with advanced disease in the first place and for whom the radiotherapy is given only as a palliative measure.

Radiotherapy methods

It is not within the scope of this article to compare the various methods of radiotherapy used. Suffice it to say that telerradium or telecobalt or super-voltage x-ray therapy are at present considered to be the best methods. The whole field is undergoing intensive development.

Surgical approach

The surgical approach to antral tumours varies little between the special clinics in London. The aim is to remove the bulk of the upper alveolus and hard palate on the side of the tumour. The floor of the nasal cavity is usually opened and the floor of the antrum altogether removed. The extent of the removal varies from case to case, but it must be enough to give a complete exposure of the tumour site. If this operation is done as the first step in the treatment, the tumour is coagulated with the diathermy current and removed there and then. The antrum and those parts of the surrounding tissues which have been invaded by the tumour are then irradiated. If this operation is done following radiotherapy, residual tumour is excavated in a similar manner.

Treatment of the cavity—At the end of the operation the cavity is dressed with a Stent mould which is replaced by a plastic obturator as soon as the cavity has healed. Sepsis and sequestrum formation often delay healing. The formation of sequestra can be minimized, at the time of the operation, by developing a precise technique in the use of the coagulating diathermy and by filletting out the thin bones of the maxilla with fine nibbling forceps, leaving flanges of mucous membrane and periosteum to protect the bone margins.

Treatment of lymphatic metastases

The question of treatment of lymphatic metastases must be considered at the same time as the treatment of the primary tumour. When no involvement is detected, the nodes should not receive treatment either by radiotherapy or by surgery. If they are involved, it is well to treat them by radiotherapy in the first place. The reason for delaying block dissection at this site (in contrast with the policy adopted towards growths of the tongue) is that they appear to be more radio-sensitive. Further, it is generally supposed that the nodes first involved are those high on the pharyngeal wall which are not accessible to excision by surgery. Should the lymphatic metastases



(a)



(b)



(c)



(d)

FIG. 1. (a) and (b) show the patient before operation. (c) and (d) show the patient after operation.

not prove amenable to radiotherapy or recur later, block dissection should be done forthwith.

Follow-up and treatment of recurrences

The cavity from which the antral tumour has been excavated and destroyed is observed carefully at intervals of one month for the first year and after that less frequently. Recurrences must be detected immediately. Here again the punch biopsy forceps are of great value in proving microscopically the presence or absence of growth. When present it must be treated without delay by further diathermy removal or by intracavitary irradiation.

Radical treatment of recurrence.—If these methods fail and the tumour is found to be extending in any direction other than posteriorly, radical excision of the upper jaw should be done by the classical method from without, and by cutting around

the tumour. The cheek is turned back by an incision cutting through the upper lip in the midline and extended up in the lateral nasal fold. It is then carried laterally just below the orbit (Fergusson's operation), or modified in some other way to meet the circumstances of the particular case (Cade and Lee, 1949). For example, if the skin of the cheek is involved, that part has to be removed together with the tumour, leaving an external defect (Figs 15c, 17a and 18a). If the floor of the orbit is involved, that has to be removed, perhaps together with the eye (Figs 15 and 17). If the growth has extended medially, it is often necessary to remove part of the nasal septum or



(a)



(b)



(c)



(d)

even the nose itself. Inferior extension may cause one to excise more of the soft palate and possibly the lip. The operation itself is crude and bloody and old-fashioned, but not to be scorned on that account.

As much as possible is done to repair the external defect at the time of the operation, but excision of the tumour must not be skimped for fear of enlarging an already gross deformity.

Later lymph-node dissection.—It is unwise to combine such an operation on the upper jaw with any major block dissection of the neck, which is done later if necessary. It usually consists of the full unilateral dissection of Crile, removing the sternomastoid and the internal jugular vein together with all possibly involved lymphatic structures.

Ethmoid tumours

The approach to these tumours is somewhat similar to the approach to antral growths. Once the diagnosis has been established, sometimes by an operation involving an incision around the medial edge of the orbit on the side of the growth, the tumour site is fully irradiated with super-voltage beam therapy. This has been found to be better than telerradium, telecobalt or radium implantation because the dose can be better calculated and more accurately applied. The higher the voltage, the less the treatment is disturbed by differential bone absorption. Everything is done to protect the eye on the opposite side but very often the homolateral eye has to be sacrificed, either to enable the tumour to be more efficiently exposed or as a result of cataract following radiotherapy.

Tumours of the nasal fossae, palate and alveolus

Radiation therapy

It has already been pointed out that these tumours are easy to diagnose, and that they are often in the form of telangiectases.



FIG. 19—Infiltrating squamous-cell carcinoma of upper alveolus and palate, internal prosthesis in position, seven years after double upper jaw excision through extensive Caldwell-Luc incision (Right external carotid artery ligated, left temporarily occluded)

(By courtesy of the Editor of *Proc. R. Soc. Med.*)

Surgery

Should radiation therapy fail, as it sometimes does, operation should follow. The type and extent of the operation must be thoroughly and carefully planned for each patient. It is impossible to lay down hard and fast rules for the surgical treatment of these growths, but the first principle of treatment is that the exposure must be adequate. This often means that the cheek has to be divided and turned back to one side or the other. Sometimes, if the tumour has not extended beyond the confines of alveolus or palate, it may be possible by ingenious design to do a radical extirpation without producing an external scar (Fig. 19). The deformity can almost always be made good by an effective and comfortable internal prosthesis.

Invasion of the maxilla by secondary carcinoma

Carcinoma of the mucous membrane of the cheek must be treated by radical surgery. Fig. 20 illustrates a patient in whom such a growth had extended not only on to the left upper alveolus but also on to the left mandible, necessitating partial excision of both these bones together with removal of the whole lining of the cheek itself. The lymph glands were involved and a block dissection was done at the time of the original operation. The illustrations show that the external deformity is not very severe. The patient has never had a prosthesis and leads a perfectly normal life, eating virtually normal food. It is in such cases that the general surgeon must not be omitted as a member of the team. Fig. 21 shows another patient in whom the upper jaw was resected for an adamantinoma. This had extended up from the right lower jaw which had been removed in the past.

Rodent ulcers of the skin invading upper jaw

These cases are usually referred to the general surgeon after radiotherapy has been tried and failed. An external defect must be accepted, the extent of tissue removal being governed by the extent of tissue invasion. Microscopical examination by frozen section is of great value in ensuring eradication of the deeper extensions of the tumour. It must be emphasized again that the terebrant type of rodent ulcer very often penetrates far deeper and more extensively than can be judged by examination from the surface. On one occasion the removal of what appeared to be no more than a radionecrotic ulcer of the bridge of the nose led the author into a deep excavation which ended only with the evacuation of rodent ulcer from the sphenoidal air sinus (Fig. 23). It is worth remembering, too, that although radiotherapy may have failed as a first line of treatment, it may be possible to return to it after the tumour has been excavated and fresh tissues have been exposed.

SPECIAL TECHNICAL CONSIDERATIONS

Control of haemorrhage

Operations on the upper jaw are often of considerable extent. Loss of blood should be made good by transfusion, but the loss should be minimized. Hypotensive anaesthesia and diathermy coagulation are of great value in this respect. Ligation of the external carotid artery also undoubtedly helps. In the case illustrated in Fig. 19, the external carotid artery was tied on one side and temporarily occluded on the other as a first step in the operation. Momentary release of the temporary occlusion proved the value of the method.

Split-thickness grafting of internal mucosal defects

Surprisingly few operations on the upper jaw require skin grafting of mucosal defects. In some cases, however, especially of tumours of the alveolus extending out on to the cheek, or of the cheek on to the alveolus, large raw areas are inevitable.



FIG. 20.—Squamous-cell carcinoma, recurring after radium therapy, of the left cheek and invading both jaws; the condition eighteen months after excision of left upper and lower jaws with Crite's block dissection of neck is shown

(By courtesy of the Editor of Proc. R. Soc. Med.)



FIG. 21.—Patient in whom right upper alveolus, hard palate and right mandible have been resected for adamantinoma.

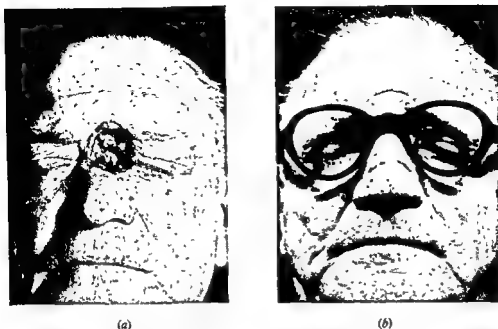


FIG. 22—Recurrent rodent ulcer of bridge of nose, extending back into the sphenoidal air sinus (a) After healing, (b) with external prosthesis in position

If they are allowed to granulate and contract, there will be gross distortion of the face by scarring from within and the healing time will be prolonged. It is better, therefore, that these surfaces should be grafted at the time of the original operation. Haemostasis is secured. A Stent mould is constructed to fit the cavity. This mould is then covered with a split-thickness graft so that the viable surface comes into contact with the denuded area of the cheek. With careful fixation this graft will take within 5 or 6 days. The graft should be generous in size. Feeding by Ryle's tube will be necessary while the mould is in place.

The internal palatal and alveolar defect

The construction of prostheses for the filling of internal defects has now reached such a degree of skill that the surgeon has come to accept of the dental surgeon a good functional result, however much of the masticating apparatus of the upper jaw has been removed (Figs. 17 and 20). The cavity into which the prosthesis fits must be prepared with care and be free from sepsis. All sharp ridges of bone should be filleted out. The dental surgeon should examine the patient before operation and will then know the type of apparatus required of him. He may even be able to make a plastic mould for the temporary dressing of the wound. Patience, however, is required in the fitting of the permanent plates and in the training of the patients in how to use them properly and to the best advantage.

The external defect

It is the external defect and the possible loss of an eye which scares patients and doctors off major operations for excision of the upper jaw. It must, however, be emphasized again that the worst defect of all is the defect of an incurable tumour fungating on to the surface and causing intense distress.

It is now possible to fit external prostheses which will enable patients to face life again with reasonable equanimity. Such appliances, however beautifully and skilfully constructed (Figs. 17b and 22b), are regrettably never entirely satisfactory. They need

constant attention at inconvenient times and they tend to leak saliva, beer, and the like. The patients find they cannot enjoy a smoke, partly because they are unwilling to risk the appearance of tobacco smoke from odd parts of their face, thereby drawing attention to themselves in a rather dramatic manner. They cannot sneeze or blow their noses without risking the precipitate dislodgement of their spectacles and part of their faces. If the apparatus incorporates an eye, the constant stare is not pleasant. From the employment point of view also, the patients find an external prosthesis a great embarrassment and employers are unwilling to accept them on account of the slightly macabre curiosity that such conditions arouse in other workers, even though the device may be well-nigh perfect (Fig. 17*b*). However, if the fistula is closed with a roof of skin (and the empty eye-socket covered with an eye-shade), the patient will be accepted without comment (Figs. 17*d* and 18*d*).

The closure of external defects should, therefore, be the ultimate object in most operations for extensive jaw resections. Many matters need to be borne in mind in planning such closures. Firstly, the tissues have usually been heavily irradiated and allowance must be made for this in the extirpation of the disease and the time allowed for healing. Secondly, growths may recur, so that only those with an associated palatal defect through which the cavity can be examined should be closed until it is reasonably certain that the growth is cured; in such circumstances 3 to 5 years must elapse. Thirdly, the patients are usually not young; they have often endured months of radiotherapy and had previous operations; they are unwilling to spend more months going through a series of plastic operations. It is advisable, therefore, to do such closures by the most expeditious method, even at the expense of visible scars on the forehead.

Lined forehead pedicle flap

The lined forehead pedicle flap has provided a solution for many of these patients. This method is singled out for emphasis, not because it is necessarily ideal but because it is usually a practicable and acceptable compromise between being left with a prosthesis and the prolonged disability and fixation necessary when skin flaps are raised from the body. The operation is done in only three stages and without immobilization.

Stage one—A pattern of tantalum foil is cut to fit the defect. It is placed on the forehead to give the size and position of the pedicle flap required, which is marked

pattern. It is folded on itself over the tantalum foil, viable side out, and buried under the end of the scalp flap. The whole pedicle, together with skin graft and tantalum, is then stitched back into place on the scalp and bandaged firmly into position (Fig. 18*c*).

Stage two.—A fortnight later the pedicle is raised again and the two halves of the split-thickness graft are separated from each other. The pedicle is brought down and its stem is tubed upon itself. The deeper grafted surface of the distal end is incised in a shallow groove around its edge to give it a double cuff. A similar incision is carried around the margins of the defect and the edges undermined, the outer edge to be stitched to the skin of the scalp flap and the inner to be stitched to the split-thickness skin graft on the under surface of the flap (Figs. 17*e* and 18*c*). All the relatively inaccessible sutures are placed before being tied so that the graft can be drawn gently and firmly into its precise position. The denuded area of scalp is dressed with tulle gras.

Stage three.—Three weeks later the pedicle is divided, the distal part is trimmed and settled into the skin of the cheek and the proximal part is returned to the bare area of the forehead. Within a week of this third stage of the operation all wounds are usually healed. The total time taken in filling in the defect of the cheek is thus 6 weeks.

When the tumour has extended far out on to the cheek and the malar bone has had to be removed together with the orbit, such a flap may be placed in position by rotating rather than by tubing the pedicle (Fig 23) In such a case the closure of the defect will be completed at the second stage of the operation, when the bare area of the scalp is covered with a second split-thickness graft. The total time for the closure of the facial defect may then be no more than 3 to 4 weeks.

JOINT CONSULTATION CLINICS

It will be appreciated that the treatment of carcinoma of the upper jaw has been most unsatisfactory in the past. With the development of special centres it is becoming



FIG 23—Photograph taken on the 21st day after commencing closure of orbital and antral defect by lined forehead pedicle flap, following excision of extensive terribrant rodent ulcer

much better, partly as a result of improvements in radiotherapeutic, surgical and anaesthetic techniques, but largely because the various members of the teams responsible for the treatment of such tumours are co-operating more closely and

team are undoubtedly the ear, nose and throat surgeon and the radiotherapist, but they must be backed up by other members who are immediately available, such as the interested general surgeon, the plastic surgeon and the dental surgeon. Every member must aim to recognize the moment that he has done all he can for a particular patient, so that there is no delay in someone else taking over. The term "Joint Clinic" must mean that the different specialists work in close, continuous and immediate co-operation.

SUMMARY

The first planned treatment of primary carcinoma of the upper jaw, by limited surgery and radiotherapy, is designed to cure with the minimum of defect. If this succeeds, the site of the growth must be kept under careful scrutiny for recurrence. If it fails

or if a recurrence develops later, more radical and traditional methods of surgery must fearlessly and unhesitatingly be adopted. The defect, whether internal or external, should be dealt with later. Secondary invasion of the upper jaw by carcinoma should usually be treated by radical surgery.

ACKNOWLEDGEMENT

I am indebted to Dr. M. Lederman and Dr. V. M. Dalley for their help in allowing me to study the figures they will soon be publishing; to Miss J. Hunt of the Royal Marsden Hospital and Mr. N. K. Harrison of St. Bartholomew's Hospital for the photographs; and to Dr. R. A. Kemp Harper for Fig. 16. Figs. 15, 17, 20 and 21 are reproduced by kind permission of the Editor of the *Proceedings of the Royal Society of Medicine*.

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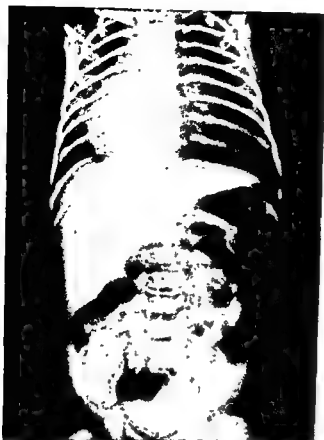


FIG. 24.—Progressive and fatal atelectasis due to bronchial irritation by gastric reflux. (Right lower lobe collapsed)

On two occasions a fine cord has been seen joining the two segments, in one of these a small cyst was incorporated. In no case did a fistula involve the upper segment and this must be considered a very rare event.

Association of oesophageal atresia with other congenital defects is said to be infrequent but the Leeds series has revealed a formidable list under the following headings:

Cardio-vascular.—Seven auricular septal defects (post-mortem findings), two auricular and ventricular septal defects (one with pulmonary stenosis), and one instance each of right aortic arch, anomalous innominate artery, anomalous right subclavian artery, and harsh systolic murmur.

Gastro-intestinal.—Three recto-vaginal fistulas, two gastro-duodenal dilatations without organic obstruction, an imperforate anus, and an ileal atresia.

Genito-urinary.—Single cases of solitary kidney, cystic ectopic kidney, and bilateral megalo-ureter.

Miscellaneous.—Two accessory auricles (one with branchial sinus), one hemi-vertebra and extra rib, and one club foot.

PHYSIOLOGY

The first hazard of oesophageal atresia is asphyxia at birth. Liquor amnii in the mouth seems excessive and is not readily cleared. Repeated inhalation of this causes cyanosis and a bubbling cry. This initial trouble gradually recedes, but is replaced by recurrent rattling in the pharynx, dribbling of saliva, and violent fits of coughing which may lead to retching and ejection of blobs of mucus from the blind oesophageal pouch. A tranquil period follows until once more the process is repeated. Under these circumstances attempted feeding is very ill-advised and results in immediate choking. Cyanosis and rejection of the feed usually through the nose. Inhalation of liquor

amni or clean saliva is of little consequence once it is cleared, but milk in the bronchial tree sets up a pneumonitis which may prove fatal.

Crying forces air from the bronchial tree through the fistula into the stomach which becomes so distended that its outline is visible through the abdominal wall. This distension often proves a serious embarrassment to respiration which is so largely diaphragmatic at this age. Distension also promotes excessive gastric secretion, and when air is returned by belching digestive juice accompanies it and severely irritates the bronchial tree, also making oral secretions acid to litmus. Excessive bronchial secretion inevitably appears leading to progressive respiratory difficulty and atelectasis (Fig 24) The time interval for this is variable and appears to be related to the extent and activity of gastric reflux, which, on occasions, has resulted in severe digestive ulceration of tracheal and bronchial epithelium.

Some early cases may be in worse condition than others reaching surgical aid when several days old. This paradox is usually related to extreme gastric dilatation which may call for urgent relief as a preliminary measure. In this respect a quiet weakly infant 3-4 days old often proves to be in better condition than a lusty one with a powerful cry, through which attention is drawn to the atresia at an earlier date by damaging the lungs with reflux.

On the rare occasions when no fistula is present the lungs remain in good condition for a long time; no gas reaches the abdomen to stimulate and distend the stomach and there is no gastric reflux to damage the bronchial mucosa or precipitate consolidation. In fact the blind termination of the upper pouch is much less of a danger to immediate survival than the tracheo-oesophageal fistula.

Dehydration with rapid weight loss makes these children wizzened and emaciated in a few days. As this progresses the bronchial secretion becomes increasingly tenacious and difficult to raise. Body temperature often falls easily to a low level particularly in the premature infant and is followed by irreversible cardio-respiratory depression.

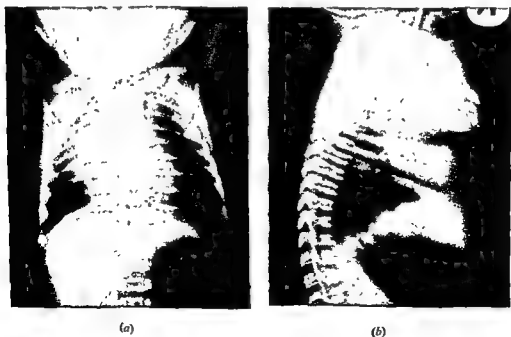


FIG. 25 —(a) and (b) Radiological confirmation of diagnosis with catheter and Lipiodol. Note: (1) gastric distension requiring preliminary gastrostomy; and (2) incomplete expansion of right upper lobe which soon cleared.



(a)



(b)

FIG. 26.—(a) Lipiodol inhaled into right lung. (b) consolidation of this area 24 hours later.

DIAGNOSIS

Familiarity with the clinical behaviour of these infants should immediately arouse enough suspicion to prevent all attempts at feeding until the oesophagus has been explored with a sterile urethral catheter. This should not be so slender that it can curl up in the pharynx to simulate a free passage into the stomach and it should be rigid enough for the fingers to recognize the point of obstruction at a measurable distance (usually 4–5 inches from the lips). This same catheter may be used to empty the accumulated mucus from the pouch by gentle suction with a syringe. Under adequate conditions in hospital, Lipiodol (but never barium) may be used for radiological confirmation (Fig. 25*a* and *b*). A very small amount is injected by catheter into the pouch since any excess over 0.5 millilitre is liable to be inhaled into the lungs where it frequently causes sufficient reaction to promote segmental atelectasis (Fig. 26*a* and *b*). For this reason it is bad policy to give Lipiodol by spoon for the examination, and all traces of Lipiodol should be aspirated as soon as radiographs have been obtained. One of those should include the abdomen to show up gas and the degree of gastric dilatation present (Fig. 25). Full lung expansion will be confirmed on the same film; a collapsed upper lobe does not necessarily mean reflux bronchial damage since this is the last part of the lung to expand after birth, but atelectasis elsewhere carries a poor prognosis. One final point should be sought, the presence of a right aortic arch which would change the side of exploration from right to left (Fig. 27).



FIG. 27—Right aortic arch requiring left-side exploration

PRE-OPERATIVE MANAGEMENT

Prior to admission

The stage is often set for success or failure of surgery at this level. Vital early diagnosis would appear to cause no special problems with only a catheter required; but because the condition is seldom encountered in home midwifery delay not uncommonly involves several days of lung damage by reflux, to which milk pneumonitis may be

added. Dehydration, temperature depression, and secretion inspissation are progressive with this delay and the earliest possible use of incubators especially for transportation does much to improve respiratory distress. It has been common practice to posture the child head down to aid elimination of saliva but this encourages deadly gastric reflux. Oral secretions should be dealt with by gentle suction using a catheter in the pharynx whilst the child is propped up to keep gastric secretions away from the cardia. Penicillin helps to combat infection, and all who handle the child should wear masks and gowns and use scrupulous care in hand washing.

Resuscitation measures

Improved results have followed full appreciation that these infants are seldom ready for surgery on admission. Instead of being rushed to theatre, most cases now spend up to 12 hours being prepared in an incubator.

Under this plastic dome the child can be nursed naked with easy access and full observation free from chilling exposure and restriction of respiratory effort by clothing. The floor of the incubator is tilted feet down and the pharynx is cleared of saliva by suction as required. In a few hours laboured breathing often becomes tranquil. Meanwhile, dehydration is adjusted with subcutaneous glucose 2½ per cent combined with hyaluronidase, saline being avoided. Vitamin K and penicillin are given prophylactically.

If breathing fails to improve in the incubator due solely to the great degree of stomach distension a preliminary gastrostomy under local anaesthesia will usually bring marked improvement.

Clinical and radiological assessment of the situation can be completed without removing the child from the incubator and when the time for operation is near an intravenous drip is started using fine Polythene tubing into the saphenous vein at the ankle. If this tubing is left long, simple strapping will keep it in place in spite of vigorous kicking because it is so light. With careful aseptic technique this drip will last several days using half strength reconstituted plasma in 2·5 per cent glucose at the rate of 300 millilitres per day. Blood loss at operation is replaced by injecting blood slowly into the drip in fractional doses 10–20 millilitres at a time. Average requirements seldom exceed 50–60 millilitres.

RECONSTRUCTIVE TECHNIQUE

Anaesthesia

Premedication for operation should be 1/400 grain atropine without a narcotic.

Induction with ether and oxygen short of full anaesthesia desensitizes the larynx for intubation and prevents bronchospasm. Excess bronchial secretion is then removed and controlled respiration with adequate relaxation is obtained on ether and 10–15 per cent cyclopropane in oxygen. Curare seems unnecessary and undesirable but when more relaxation is required for a difficult stage of the operation an ultra-

1 milligram per
tomach becomes
en done and the

tube remains open.

Operation

As already mentioned, where gastric distension is present a gastrostomy is made before the chest is opened.

Provided the aortic arch lies on the left, the right fourth rib is removed and an extra-pleural strip carried out to expose the posterior mediastinum from the pleural apex to the lung root (Fig. 28 (1)–(8)). Apart from later advantages this strip, which is

not difficult, helps in control of the lung by retractors. The vena azygos is divided

the trachea with fine catgut, the tip of the lower segment may need trimming back a few millimetres if its blood supply is in doubt.

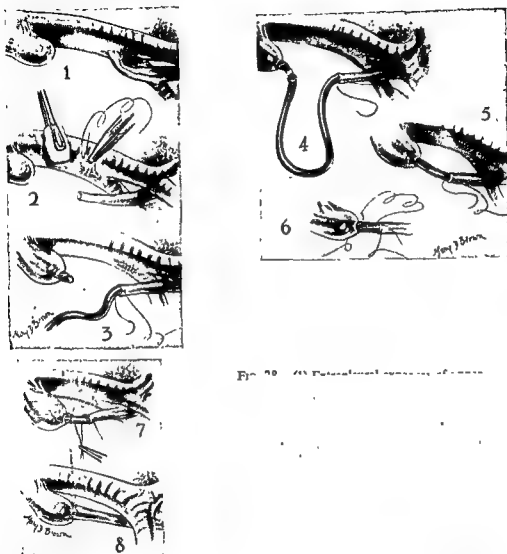


Fig. 70. Esophageal atresia.

Anastomosis

An end-to-end reconstruction is completed after splinting both segments with a catheter, which is first passed into the stomach through the lower segment. As mucosal retraction easily occurs the first interrupted stitch is placed in the lower segment before the catheter is introduced. After the blind pouch has been opened the proximal end of this catheter entering the stomach is withdrawn into the mouth by stitching it to a catheter previously introduced by mouth. Interrupted stitches are placed in a single row, three on each side.

ted, leaving knots entirely on the outer surface; a good watertight joint is then

produced, in spite of a certain amount of tension. The splint catheter is then withdrawn.

Drainage

As the chest is closed a small underwater drainage tube is left in the extra-pleural space together with antibiotic powders. If not already done a gastrostomy is best provided in all cases. The finest chromic catgut seems the most desirable suture material for such a delicate oesophageal anastomosis, but sometimes variable tension requirements may call for something stronger. Thicker catgut is too bulky for a neat result free from stenosis and the best alternative is a very fine steel wire or nylon both of which can be obtained in a pliable plaited form easy to handle. Silk causes too much tissue reaction and spread of infection by capillary attraction.

A wide gap may be impossible to bridge by direct anastomosis and this is usually the case when the lower segment is in part atretic and no gas is seen in the abdominal radiograph (Fig. 29). With this situation two lines of thought have developed. The



FIG. 29.—Abdomen free from gas in atresia without fistula.

first is a strategic retreat with cervical oesophagostomy and gastrostomy. Survival from this produces a pitiable child who at best cannot learn to eat until months later, when multi-staged plastic operations have produced an antethoracic oesophagus, after much distress to all concerned. The alternative plan is an all-out attempt at bridging the gap using a free Thiersch graft as a skin-lined tube sutured to each segment. Such an attempt on one case in Leeds very nearly succeeded when a small leak caused death from an empyema. When examined at autopsy three weeks after operation 90 per cent of the graft had taken.

POST-OPERATIVE CARE

To avoid interference with chest movement wound dressing should be very light and strapping reduced to a minimum, but the three essential tubes, chest drainage, gastrostomy and intravenous drip should be secure.

Immediately after bronchial toilet and removal of the intratracheal tube, no time should be lost in returning the child to an incubator ready waiting for it in the theatre. This is a priceless asset in dealing with the nursing problems of this stage. Breathing is unhampered by clothing in an atmosphere free from droplet infection yet moist and



FIG. 30.—Gastrostomy feeding technique in an incubator

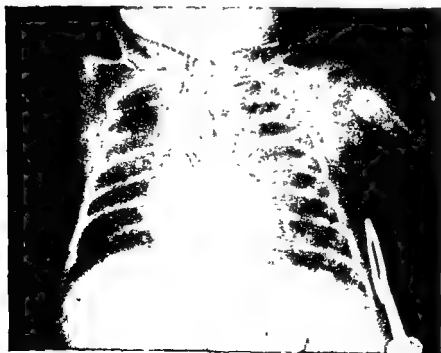
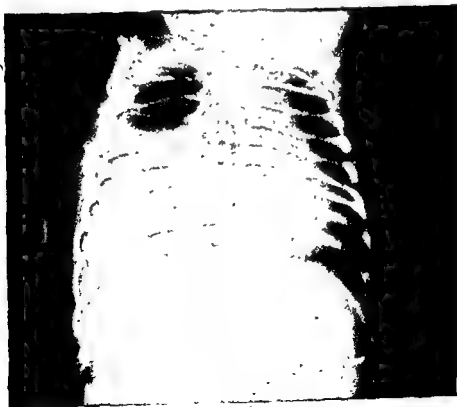


FIG. 31 —Anastomotic structure



(a)



(b)



(c)

FIG 32.—(a) Localized extra-pleural leakage healing spontaneously on gastrostomy feeding; (b) large leakage, with extra-pleural pneumothorax, requiring closed intercostal drainage; (c) fistula tube track when nearly healed by intercostal drainage

maintained at 90°F. with additional oxygen in known concentration if required. Regular changes in posture are made from side to side, yet handling is reduced to a minimum without loss of efficiency. Many of these babies are premature and require special attention on this account. In particular, temperature regulation defects are critical after surgery. The need for chest drainage ceases after a few hours and unless the tube is removed it may provoke unnecessary fluid accumulation, lung damage or restriction of chest movement.

Circulation and fluid balance

Blood is seldom needed after replacement of the loss during operation, but fluid balance requires intravenous therapy for 2-3 days at least before gastrostomy feeds may be started. Half-strength reconstituted plasma in 2.5 per cent glucose provides protein, carbohydrate and water in physiological amounts, but the daily intake should not exceed 300 millilitres. Saline should be avoided since the neonatal kidney is extremely conservative with salt and oedema may result.

Respiration

Routine turning from side to side encourages regular expansion of both lungs and clearance of bronchial secretion particularly in conjunction with head-down tilting of the mattress which can be permitted now the fistula is closed. Tenacious secretion may be loosened by detergent mist from an atomizer. If breathing becomes laboured or rattling in character retained secretion should be suspected even when the lungs

show radiological translucency. It is easier to clear the trachea at this stage than to wait for atelectasis to develop. A small laryngoscope and a fine bronchial sucker used with full aseptic precautions and minimal trauma by a skilled endoscopist gives better results than a suckling bronchoscope.

Caution should be used with oxygen therapy since exposure to concentrations above 60 per cent for any length of time carries serious risk of lens damage in the newborn.

Feeding

A cautious start is made with gastrostomy feeds at about the third day using 2 drachms of weak glucose hourly and watching gastric residue before each feed. Without this care a large vomit easily proves fatal from inhalation asphyxia at this stage. By gradual progress to half-strength milk, feeds are built up, watching for diarrhoea from fat intolerance—a not uncommon occurrence.

All feeds should be given very slowly using a small head of pressure by gravity only (Fig. 30). Milk should be cleared from the gastrostomy tube with a little glucose otherwise rennin from the gastric juice will block it with junket. Unexplained vomiting or diarrhoea may be due to the gastrostomy tube which is liable to be left a little further in the stomach each time the dressing is done. Unless the position is corrected regularly it either coils up and irritates the stomach or passes into the small bowel causing diarrhoea.

It is probably inadvisable to permit glucose feeds by mouth before the seventh day, by which time leakage is less likely to appear and oedema should have cleared leaving a reasonable lumen. The appearance of dysphagia at this stage is usually due to focal infection which should be left strictly alone to settle down without dilatation or further feeds by mouth. A true anastomotic stricture and if oesophagoscopy reveals no infla dilated again at regular intervals by anaesthesia.

Early feeds are seldom completed by mouth and the residue is given by gastrostomy tube which is retained if necessary for several weeks until suckling is strong and weight is increasing steadily.

POST-OPERATIVE COMPLICATIONS

Stenosis

Slow feeding and a crowing cough are the warning signs of obstruction but unless these are severe it is easy to withhold dilatation too long, with serious consequences from chronic lung infection (Figs. 31 and 34). Stenosis seldom responds to a single dilatation and those concerned with managing the child after it leaves hospital should be aware of this since the need for further attention varies in an unpredictable way for several months, although the ultimate prognosis is good.

Anastomotic leakage

If early in appearance this is usually a technical fault often based on unavoidable tension at the suture line. Local sepsis may cause leakage a few days later, and during this period it is distinctly unwise to attempt dilatation of an inflamed anastomosis.

With crying or respiratory distress the diaphragm pulls hard on the lower segment repeatedly and few other viscera would heal an anastomosis under such tension, yet in this series only 7 leaks occurred with 35 operations. After transpleural reconstruction a pyo-pneumothorax from leakage was invariably fatal, but with an extra-pleural approach the infected space was limited and even when large enough to warrant closed intercostal drainage it usually healed remarkably well whilst feeding continued by gastrostomy (Fig. 32).



(a)



(b)

FIG 33—(a) Recurrent tracheo-oesophageal fistula; (b) after surgical repair

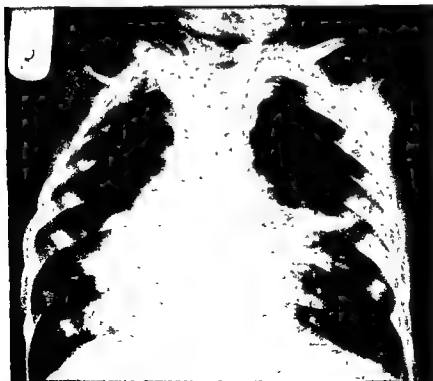


FIG 34—Bilateral bronchiectasis caused by stenosis and inhalation of feeds.

Recurrent tracheal fistula

This occurred twice and one of these was successfully repaired when it failed to heal after conservative management for a month (Fig. 33).

Dysphagia without stenosis

Some of the survivors have a crowing cough, frequent attacks of sneezing and derangement of the pharyngeal swallowing mechanism. The noise they produce is characteristic but the cause remains unexplained. Some neuro-muscular incoordination seems to be present and may be inherent with atresia, but vagal damage at the operation site cannot be excluded.

High intestinal ileus

Twice some apparent intestinal obstruction has been met. Lipiodol would not pass the pylorus in one and the duodeno-jejunal flexure in the other yet in both meconium had been passed. *When explored no organic obstruction was found, and this neuro-muscular disorder, probably related to the vagus nerves, has led to greater respect in handling them during the reconstruction.*

Bronchiectasis

This is a consequence of untreated anastomotic stenosis which causes chronic lung infection by repeated inhalation of feeds, and has virtually disappeared as a complication since the association was appreciated and the necessary dilatations were provided (Fig. 34).

OESOPHAGUS—THE SURGICAL ANATOMY OF COMPETENCE AT THE CARDIA AND ITS RESTORATION IN HIATUS HERNIA

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Importance of the correctly-functioning cardia

The cardia is so designed that it permits unobstructed passage of nourishment or air into the stomach yet resolutely prevents return of either except by the organized processes of belching or vomiting; and this restraint is accomplished regardless of extreme physical exertion or postural change. The cardia mechanism is so smooth that it is easily belittled by inadequate description, and even more easily taken for granted when mutilated by carefree surgery. To the well-being of the individual it may rank in importance just as high as continence at the anal sphincter, and no ingenuity is too great when aimed at restoring this function when deranged by herniation at the diaphragmatic hiatus. As the components of the cardia mechanism are examined in detail, together with the possible consequences of too much active gastric juice in the oesophagus (Aylwin 1953), it is clear why displacement of the cardia is the main cause of incompetence and how best this is controlled by restoring normal anatomy as stressed by Allison (1951).

THE MECHANISM OF COMPETENCE

For descriptive purposes the composite anatomy relative to the function of the cardia is best broken down into three parts: (1) the contractile diaphragm round the oesophagus; (2) the oblique gastric muscle and mucosa near the cardia; and (3) the fascial link combining these structures.

To avoid misleading terms like sphincter and valve is proper name for the whole appears to be "the cardia mechanism."

The hiatal muscle

This muscle is thick and fleshy round the oesophagus and takes the form of a sling, the limbs of which have unilateral innervation respectively from the right and left phrenic nerves, and its extremities are attached to the left leaf of the diaphragmatic central tendon and the first three lumbar vertebrae as part of the right crus. When contracting, this sling draws the cardia more to the right than downwards (Fig. 35) and grips it tightly; a combined movement which is appreciated clearly during oesophagoscopy, or by palpation when the abdomen is open under local anaesthesia. A similar angulating constriction is applied to the intestinal tract at the pelvic diaphragm by the pubo-rectalis section of levator ani; and in like manner at the hiatus, force meets force when intra-abdominal pressure is raised by straining. Furthermore, neither of these sling muscles may be cut, scarred or paralyzed without serious risk of lost control. There are minor bands of muscle crossing behind the

oesophagus from one muscle limb to the other in most individuals. These slivers carry the nerve supply of their sides of origin, and fortify the hiatus against divarication.

The ligaments of the cardia

These ligaments support the lower end of the oesophagus like the guy ropes support a marquee against forceful up-drafts. This fascia from both surfaces of the diaphragm unites at the margins of the hiatus to bridge the narrow gap and reach the oesophagus. There it unites with the loose but strong fascia propria at a level several millimetres higher than the mucosal junction of oesophagus and stomach (Fig. 36). This union sends many fibres which penetrate the muscle layers of the oesophagus to gain a firm attachment to the mucosa across the mobile submucous plane at the same level. At other levels there is nothing comparable with this circle of fixation, which may be



FIG. 35.—The diaphragmatic hiatus from below, showing the arrangement and action of the hiatal sling

demonstrated at oesophagoscopy by testing for mucosal mobility with a swab. It may be seen during Heller's operation for cardiospasm, when it is easily responsible for an inadvertent nick in the mucosa. Furthermore, it can be shown in fresh post-mortem specimens by injecting fluid under the mucosa of stomach or oesophagus which elevates the mucosa easily except along this line just a few millimetres above the cardia (Fig. 37). This phreno-oesophageal ligament carries small branches of the

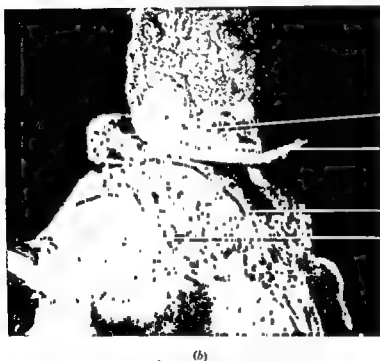
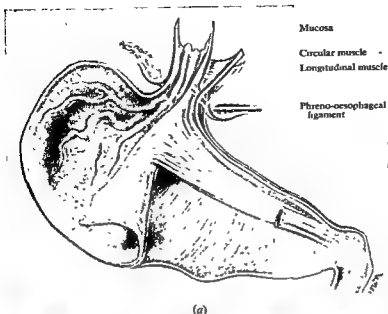


FIG 36 —(a) The phreno-oesophageal ligament and its deep penetration of the oesophagus to provide a ring of mucosal fixation, (b) external anatomy of the cardia showing diaphragm (D), phreno-oesophageal ligament (L), peritoneal reflection (P) and bare area of left gastric pedicle (B) Left lateral view

left gastric vessels through to the mucosa of the cardia, concentrated mainly in the posterior quadrant of its circumference. It is confined between pleura and peritoneum to which it is loosely bound by areolar tissue and fat. Heavy deposits of this fat posteriorly may form a "sentinel lipoma" to herniation, as seen so frequently with inguinal hernia. When the ligament is elongated equally throughout its circumference a sliding hernia with reflux results; but if the weakness is confined to one sector a

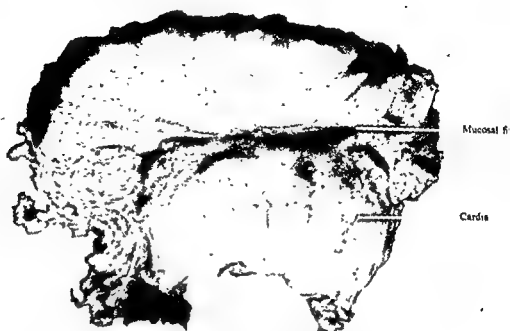


FIG 37—Submucous injection of fluid at the cardia showing the circle of mucosal fixation to the phreno-oesophageal ligament

para-oesophageal hernia occurs without necessarily displacing the cardia, and so competence is usually retained.

The oblique gastric muscle and cardiac mucosa

These together form the deepest links in the cardia mechanism. All muscular and mucosal attachments in the area and the distribution of the oblique muscle fibres are best demonstrated after fresh specimens have been boiled to the consistency of tripe to facilitate dissection

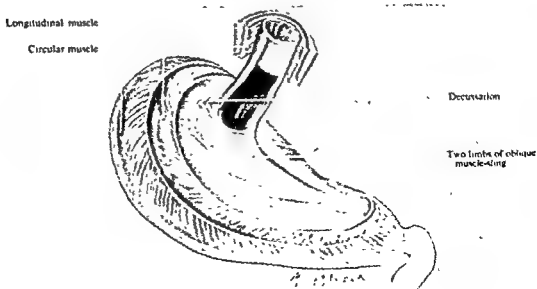


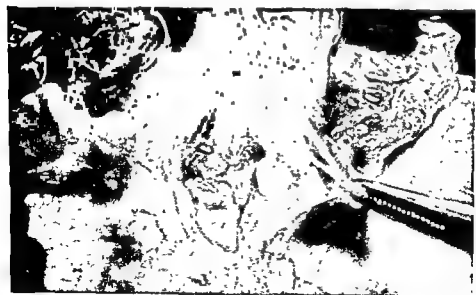
FIG. 38—Anatomy of the oblique muscle.

The oblique gastric muscle

This muscle lies deep to the circular and longitudinal muscle layers and, unlike these, it has no counterpart in the oesophagus with which it can establish continuity. Instead it is firmly attached to the circle of oesophageal mucosal fixation from which it obtains a fixed point for its activity, as well as some purchase from the decussating fibres which loop over the incisura between the fundus of the stomach and the oesophagus (Figs. 38 and 39). As these fibres sweep down the stomach they gain some attachment to the surrounding mucosa, then become concentrated into anterior and posterior bundles along the upper half of the lesser curvature. There they are firmly



(a)



(b)

Fig. 38. (a) Dissection of the stomach showing the oblique gastric muscle. (b) Dissection of the stomach showing the oblique gastric muscle.

united to the gastric mucosa by a broad line of fixation, corresponding with the *magenstrasse*, and starting 2-3 centimetres below the cardia but gradually fading out towards the pyloric extremity. Elsewhere the gastric mucosa is noted for its free mobility over the gastric muscle which permits formation of thick *rugae*.

Of these attachments of the oblique muscle the fixed one is oesophageal and, with each increase of gastric tone, mucosa is drawn up towards it, causing a redundant mucosal fold to encircle the cardiac orifice. When it relaxes, as it does to some purpose in the atonic first phase of the vomiting reflex, this frill of redundant mucosa is stretched out and the cardiac orifice is transformed from a *pouting rosette* into an open funnel. It is common to find this muscle erroneously described as pulling the cardia down when in fact it lifts the gastric mucosa up. Its action is the reversed counterpart of the detrusor of the bladder in which relaxation produces continence but contraction initiates micturition.

The submucosa round the cardia

At the cardia this layer has a special abundance of elastic tissue which elsewhere is relatively sparse. This gives it an elastic quality of extra recoil, which helps to form the mucosal rosette in conjunction with contractions of the oblique gastric muscle



FIG 40—The mucosal rosette round the cardia. (a) during contraction of the oblique gastric muscle, (b) relaxed in preparation for vomiting

(Fig. 40). Together they provide the fine adjustment of the cardia mechanism whilst the diaphragm provides the coarse control as well as the fixed point from which the fine adjustment is made.

When herniation takes place the two parts of the mechanism lose their alignment, and when the pouch of stomach within the chest is inflated by abdominal straining into its usual globular shape the mucosal folds are obliterated by distension into the position required for vomiting or free reflux.

Function

From a functional point of view the cardia mechanism is fully automatic, being controlled by gastric tone and the efforts of the diaphragm which always contracts with the other abdominal muscles in straining. There is, however, experimental evidence from cats which indicates the presence of a reflex stimulation of the fine adjusting mechanism. This is initiated by gastric acid in the lower oesophagus, mediated through the vagus nerves to cause immediate increase in gastric tone in which the oblique muscle plays its part by enfolding the gastric mucosa round the cardiac orifice. If this were confirmed in human subjects it would form a further embellishment to this intricate mechanism required for the protection of the oesophagus from potent juices which are an inherent part of our carnivorous existence.

RESTORATION OF COMPETENCE

Most commonly incompetence is caused by herniation of the cardia out of its normal relationship to the diaphragmatic hiatus, and treatment is concentrated on restoring the normal alignment of these structures. Rarer causes of incompetence, which are mostly temporary, involve neurogenic or mechanical disturbance of the mechanism without displacement, and are secondary manifestations of other gastro-intestinal disease seen principally in the very young and in those subject to peptic ulcers. The cardia may be embarrassed from nearby gastric ulceration, oedema or scarring; it may remain fixed in the position for vomiting over prolonged periods of nausea. In these circumstances treatment is aimed at the cause rather than the incompetence, and is usually conservative.

With hiatus hernia, successful restoration of competence is dependent upon two important premises:

(1) Before operation there should be freedom from certain complications of the hernia (2) After operation the readjusted moving part of the mechanism should be left in correct alignment, and in normal working order unhampered by scar tissue or unnatural deformity.

Complications precluding successful reduction

Stricture formation from reflux peptic erosion of the oesophagus

This stricture shortens the oesophagus, destroys mucosal mobility and leaves stenosis with continuing incompetence, even though the cardia may be replaced (perhaps with difficulty) in some instances. Between superficial erosion of the oesophagus and stricture formation there are all grades of damage with no clear dividing line; the extent of damage must be judged at oesophagoscopy, and the chance of a successful reduction thus assessed. It follows that in any large series there must be a proportion of "trial reductions" since the alternative is an extensive operation for resection which is not to be undertaken lightly.

The gastric-lined oesophagus

This rare anomaly is always accompanied by hiatus herniation, and operative reduction in these cases is unlikely to succeed since it is being practised on an abnormal cardia mechanism; moreover, the gastric mucosa in the oesophagus remains particularly prone to chronic gastric ulceration with stenosis if this has not already occurred. The condition may be suspected from radiology but is confirmed only by oesophagoscopy.

Obesity

Obesity is more of an aetiological factor in hernia development than a complication, but it is also an important factor in causing recurrence, so surgery should be avoided until it has been relieved by dieting, and weight control should continue as an important part of after-care.

Surgical repair of the cardia mechanism

By far the best exposure is obtained through the left chest after removal of the eighth rib. The mediastinal pleura is incised (Fig. 41), the oesophagus isolated with both vagi, and a tape passed round it to limit reflux during manipulation, and provide a means of retraction as the repair proceeds. Both margins of the hiatus are cleaned (Fig. 42). The diaphragm is incised anterior to the spleen, avoiding the posterior (hiatal) branches of the phrenic nerve and as many more branches as possible. With

two fingers of the left hand in the hernia sac the stretched components of its wall, phreno-oesophageal ligament and peritoneum, may be trimmed to a frill 1 centimetre wide on the left, anterior and right aspects of the cardia (Fig. 43). The posterior bare area containing the left gastric vessels is left undisturbed apart from removal of a sentinel lipoma of extra-peritoneal fat, if this is present. The tape round the oesophagus is then transposed through the hiatus and its ends splayed apart with slight traction to draw the cardia down

The extent of the divarication at the hiatus is then easily inspected from above. This usually requires one or two loosely tied approximating sutures through the margins behind the oesophagus, and one in front where decussating marginal fibres may seem weak and thin (Fig. 44). These are left untied until a later stage to avoid *cramping the next procedure of suturing the shortened attachments of the cardia to the under-surface of the diaphragm round the hiatal margins*. Through the incised diaphragm about six interrupted silk stitches are placed in a horseshoe arrangement round the cardia, each one picking up peritoneum, phreno-oesophageal ligament and then under-surface of diaphragm (Fig. 45) starting with the first on the right side of the cardia and continuing round the front aspect with successive stitches placing the last on the left side. Meticulous care is required to ensure that the phreno-oesophageal ligament is picked up and identified each time by its firm fixation to the cardia and none of the stitches should be tied until all are in place. The phrenic vessels are near and damage to them should be avoided. The loose hiatal approximating stitches are tied and the repair is tested for security with a finger from below before

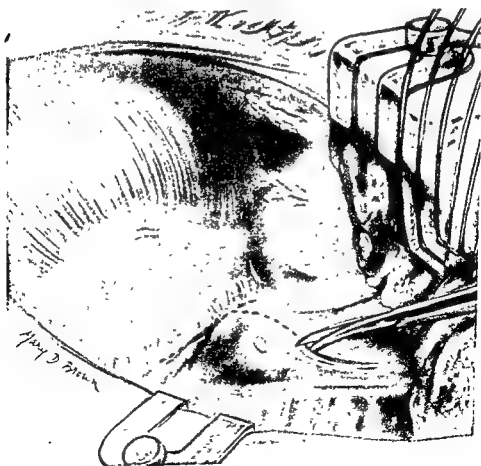


FIG. 41.—Mediastinal incision of pleura for exposure of the cardia and hiatus

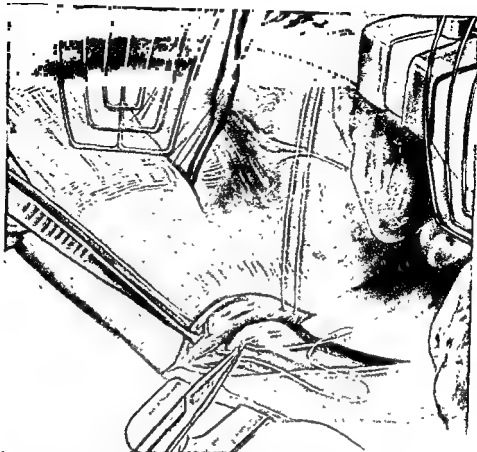


FIG 44 —Approximation stitches for the divaricated hiatal margins. Loosely tied behind and in front of the oesophagus these restore normal size to the hiatus without ischaemic necrosis of this irreplaceable muscle

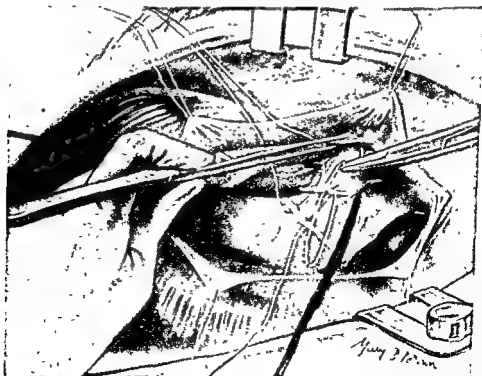


FIG 45 —With interrupted stitches the frills of peritoneum and phreno-oesophageal ligament are stitched to the under-surface of the diaphragm.

PLASTIC PROCEDURES

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THE ABBÉ OPERATION

Abbé in 1898 described an operation for the correction of the flat tight upper lip which may be the sequel of an improper primary repair of a congenital cleft (Fig. 46)

Indications

Similar deformities of the upper lip can be found following excision of tumours, scarring from injury, facial hemiatrophy, noma and syphilis

The operation

The principle of the repair is the transposition of a full thickness flap of tissue containing skin, muscle and mucosa from the lower lip on a small pedicle on the lip margin into the upper lip defect. The pedicle contains the inferior labial artery which provides adequate nourishment for the flap until its new circulation is established. Two stages are necessary and a minimum of two weeks should elapse before the second stage is contemplated.



FIG 46—Deformity following improper repair of cleft lip.

Stage one (Figs. 47 and 48)

General anaesthesia with naso-tracheal intubation or local anaesthetic may be used.

The true defect in the upper lip is created by excision of scarred tissues and release of tension by division of bands adherent to the upper alveolus. In most cases the defect will assume, or can be made to assume a triangular shape with its apex above.

A triangle of similar size is marked out in the lower lip opposite the defect. This triangle has its base at the lip margin and its apex towards the chin.

The lip is held on each side between the fingers, put slightly on the stretch and with a Bard Parker No. 11 blade it is completely divided through along one side of the triangle so that it is virtually severed in two parts. Bleeding vessels on the lateral lip element are caught with haemostats.

The other side of the triangle is then similarly incised from below upwards until the vermillion border is reached. On no account at this level should the labial artery be divided. Haemostasis is effected on the opposite labial lip element and the triangular flap is then ready for transposition.

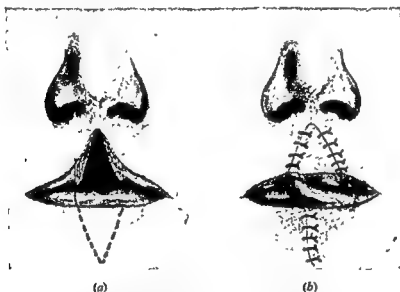


FIG 47—(a) Defect in upper lip created by removal of scar. Flap marked in lower lip, (b) flap transposed into defect.

This triangular flap can hinge easily into the upper lip on its small pedicle and when it is in position it is accurately sutured. The mucosal layer is stitched first, then the muscle, and lastly the skin.

It will be found convenient to put a few mucosal and muscle sutures in the lower lip before the flap is completely inset as this will draw the lower lip together and thus determine the final position of the flap itself.

The lower lip suturing is then completed and the final sutures are put into the vermillion border. No raw area remains and the circulation of the flap should be perfectly satisfactory.

Post-operative feeding and removal of stitches.—Feeding is the main problem after this operation and for the first few days a feeding cup is necessary. Later, however, it is amazing to discover that patients are able to manage quite well with semi-solid or even solid foods. The stitches are removed on the fifth and sixth days.

Stage two

Two to three weeks later, provided that healing is complete, the pedicle is divided under local anaesthesia and each lip margin is carefully repaired after the small



FIG 48.—Flap healed into upper lip. Now ready for severance of pedicle.



FIG 49.—Improvement in lip length following Abbé operation (see Fig 46).

mucosal flaps have been trimmed and inset. If the original suture lines have been accurately placed, the vermilion border of each lip will be well aligned and it will not be difficult to get a smooth contour on the lip margin.

These few sutures are removed on the fourth day, after which no particular treatment is required. It will be noticed that there is no apparent reduction in the horizontal length of the lower lip, and as the scars resolve after a few weeks, a most acceptable result can be expected (Fig. 49).

THE BAT OR WINGED EAR DEFORMITY

Indications for treatment

Protrusion of the ears becomes a disability when it is of such a degree that remarks are passed either to the parents of the child, or to the child itself (see Fig. 50). It is of course more noticeable in boys as it can be hidden by girls by suitable arrangement of the hair. Nevertheless both sexes are frequently presented for treatment. There is little doubt that the psychological trauma which results from schoolboy ribaldry can have a lasting effect, and may show itself later in life in a variety of abnormal behaviour patterns.

There is thus justification for intervention in these cases. Ideally, operation should be carried out during the fifth or sixth year.

The operation

The method advocated was first described by Luckett (1910) who pointed out that the deformity was due to failure of proper formation of the antihelix. The aims of the procedure are to reform the normal shape of the antihelix and in cases where there is over-development of the concha, to reduce this part of the cartilage to an acceptable size and shape.

General anaesthesia with intratracheal intubation is used. The child is placed in the supine position on the table with the head resting on a small pillow, or a ring sand bag. After thorough soap and spirit cleansing the operation area is towelled off.

An ellipse of skin is marked on the posterior surface with Bonney's blue, the long axis of the ellipse being the line of the proposed antihelix. The upper limit lies just below the rim of the helix at the point where it should be joined by the superior crus of the antihelix and the lower limit is at the level of the antitragus. The maximum width of the ellipse is about 2 centimetres.

The skin markings having been made the tissues on the posterior surface of the pinna are infiltrated with 1 per cent Xylocaine with 1 : 100,000 adrenaline. The ellipse of skin is then excised and the cartilage cleared of soft tissue remnants.

The pinna is then folded back so that a ridge is produced on the anterior surface representing the site of the antihelix. This ridge, passing up from the antitragus curves forwards across the scapha until it meets the helix well anterior to the highest point of the pinna. This ridge is marked with ink. In some cases it may be advisable to reconstitute both crura of the antihelix, the line of the inferior crus is also inked in.

In order to mark the posterior surface of the cartilage a straight cutting needle is thrust through in four or five places along the lines marked out, its tip is inked and it is then withdrawn leaving an ink mark in the cartilage itself. Thus the line of the antihelix is projected on to the back of the cartilage (Fig. 51a).

With the ear held forward three parallel incisions, each 2 millimetres apart, are made along the whole curve of the antihelix so that the cartilage is completely divided without cutting the anterior skin (Fig. 51b). The rim of the helix is not cut through as the incisions start about 3 millimetres from it. The ear can then be folded back and the new antihelix will take shape without much tendency to spring. Where there is a large scapha a single cartilage incision in the line of the inferior crus is made to join the previous triple incision.



FIG. 50—Bat ears. Posterior view



In cases where there is over-development of the concha this is now reduced by a crescentic reduction at its free edge and if the antitragus is too prominent its cartilage is similarly reduced in size.

The new position is maintained by putting in three or four horizontal mattress sutures of 4/0 silk into the cartilage in either side of the new fold, the stitches passing through half the thickness of the cartilage so that they are not visible under the anterior skin. When all the stitches are in position they are tied and the ear takes up its new shape.

After complete haemostasis has been achieved, the original post-auricular ellipse is closed as a linear suture line with mattress sutures of fine silk.

Dressing

The dressing is of considerable importance to prevent haematoma and oedema. A small plug of Vaseline gauze is placed in the meatus and then pledgets of wool damped in Whitehead's varnish are packed into the conchal cavity, the fossa triangularis, the scapha, and along the sulcus between the helix and the lower part of the antihelix. This forms an accurate mould of all the new contours and preserves the shape obtained at operation.

A wool pad and bandage complete the operation and this is left in position for six days, at which time the post-auricular sutures are removed.

The parents are instructed to put on a head bandage, at night only, for a month to prevent shearing stress while the child is asleep



FIG 52—Result of correction of bat ears



FIG. 53.—Rhinophyma. Note the "butterfly" distribution.



FIG. 54.—Corrected rhinophyma

RHINOPHYMA

Pathology

This progressive enlargement of the nose due to hyperplasia of the sebaceous gland elements of the skin is a condition which responds well to treatment. It is not always confined to the nose but may affect a "butterfly" area to include part of both cheeks as well. It is seen in males from the fifth decade onwards and the deformity can become quite grotesque (see Fig. 53). A pustular dermatitis is sometimes associated with it and this should be cleared up before operative intervention.

Operation

General anaesthesia with intratracheal intubation is the method of choice and a hypotensive technique greatly simplifies the procedure. Bleeding is the main difficulty and if this can be significantly reduced by the use of one of the hypotensive drugs, visual control of the excision allows much greater accuracy.

The technique advised is to shave away the excess of tissue until a normal size and shape is obtained (Fig. 54). A study of the various contours of the normal nose should be made as proper definition of the natural form should be the aim.

The excision starts above and is done with a No. 10 Bard Parker blade. The edge of the blade soon becomes dull so that as many as six may be necessary; therefore these should be at hand.

When the upper and middle thirds of the nose have been shaved down to an acceptable size, the tip should be carved away to match it, special attention being paid to the columella and alar margins. The supra alar curve should be well defined and the normal fullness of the alar base reproduced. A proper modelling of the various curves of the tip completes the procedure.

In most cases no skin graft will be necessary and it is wise to avoid this if possible as natural healing will produce an excellent texture and normal colour.

If, however, the nasal cartilages or large areas of subcutaneous tissue have been exposed a split skin graft should be cut and applied with suitable fixation and pressure dressing.

Post-operative treatment

If no graft is necessary the raw surface is covered with Vaseline gauze which is left undisturbed for 7-10 days when healing will be found to be complete. The patient is advised to massage the nose gently with a little lanoline for three to four weeks after operation; if the skin pores are excessively dilated an astringent lotion may be advised to aid resolution.

SADDLE NOSE

Causes

As the name implies this deformity is a depression of the middle third of the bridge of the nose. It is due to loss of support of the nasal septum and this may be brought about by the following factors.

(1) A direct blow on the tip of the nose may fragment the septal cartilage and cause a collapse.

(2) Submucous haematoma of the septum resulting from injury if undrained may result in absorption of part of the cartilage.

(3) Septal abscess which usually arises in a haematoma may cause extensive loss of septal support (Fig. 55).

(4) Saddle nose is sometimes seen as a complication of the operation for submucous



FIG 55—Saddle-nose deformity following septal abscess

resection for a pre-existing septal deformity. Care should be taken in performing this resection not to remove the anterior and inferior parts of the cartilage as these should always be retained for support.

(5) Syphilis, lupus and leprosy, all of which attack the septum, may cause a saddle deformity but in this group the picture is complicated by more or less extensive loss of mucosa in the nasal cavity, and the treatment to be described is not applicable in many of these cases.

Indications for treatment

Most patients present themselves for cosmetic reasons, and complaint of a considerable change in appearance may well be justified because the nose is such a prominent feature.

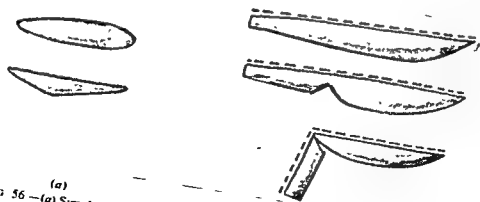


FIG 56—(a) Simple "boat-shaped" inlay. (b) hinged cartilage graft for extra tip support.

Loss of bridge support sometimes impedes the airway, as support for the tip is lacking, the alar region droops and interferes with the airstream. Associated with saddle nose there may be a deviation of the remaining septum which is causing the blockage. If there is any doubt as to the cause of the obstruction, the nares can be gently elevated with a nasal speculum and the patient will immediately remark on the improvement in breathing if tip sag is the cause.

Treatment

Any septal deviations or spurs should first be corrected by the standard procedure of submucous resection. Three months should then elapse before correction of the external deformity is undertaken.

Anaesthesia

General anaesthesia with intratracheal intubation is satisfactory. Half an hour before operation the nose is packed with half-inch ribbon gauze soaked in equal parts of cocaine, 10 per cent, and adrenaline 1/1,000, and this may be supplemented by an infiltration of the membranous septum and subcutaneous tissues of the bridge of the nose with a small amount of Xylocaine, 1 per cent, with 1/100,000 adrenaline.

Operation

Autogenous cartilage is recommended as a graft for these cases and this is obtained from the seventh, eighth or ninth costal cartilage. A transverse incision in this region, while not giving the best access, heals with a less conspicuous scar than any other.

The desired cartilage is exposed and removed with its perichondrium in an amount somewhat greater than will be required. The chest wound is closed.

The nose is opened by a vertical incision in the membranous septum on one side and this incision is carried laterally for a short distance between the upper lateral and the alar cartilage.

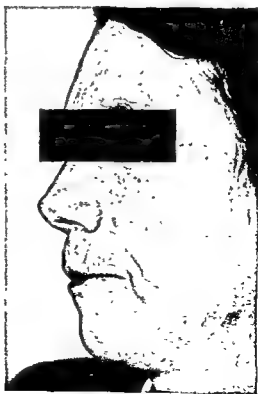


FIG 57 —Saddle deformity corrected by cartilage implant

Normal tip position.—If there is no depression of the tip the two mucous surfaces of the upper septum are gently separated and the bridge of the nose is undermined over the area of depression until a pocket is formed for the reception of the graft. A thorough dissection of the septum without perforation is important as it will afford space for a full sized transplant. Then it will be seen that the cavity produced is roughly boat-shaped and the cartilage is fashioned accordingly (Fig 56a) and inserted into its bed. If the graft is accurately shaped the deformity will immediately be corrected and the intra-nasal incision is closed with fine catgut sutures.

Depressed tip.—If tip depression is present additional support will be required, and the two layers of the membranous septum should be dissected free from each other to the anterior nasal spine. In this way space is created for the inclusion of an anterior strut of cartilage. The bridge cavity is prepared as described.

In these cases a hinged cartilage graft is used, the bridge piece and the tip support being shaped from a single costal cartilage but they remain connected by a strip of perichondrium. The bridge piece is inserted first and the length of the anterior support is then estimated, the cartilage is trimmed and introduced so that it abuts on the nasal spine. An L-shaped cartilage implant then supports the nose (see Fig 56b).

Dressing

The whole nose is carefully supported with strips of half-inch strapping so that the soft tissues are held in close contact with the graft. A light nasal pack of Vaseline gauze is inserted for twenty-four hours, and the strapping is removed on the fourth day. An illustration of corrected deformity is shown (Fig. 57).

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POLIOMYELITIS: THE DISTRIBUTION OF THE PARALYSIS

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MUSCLE PARALYSIS IN THE ACUTE AND CONVALESCENT STAGES

The initial paralysis

The demonstration of weakness of one or more muscles in a limb is often the first certain indication that a patient is suffering from acute anterior poliomyelitis. The paralysis may progress in one of several ways. As a rule, it reaches its maximum within 48 hours of its appearance; in some cases it may continue to increase in a limb, or appear in other limbs for several days. The return of a normal temperature in most patients determines the end of the spread of paralysis, but it is not safe to assume that no further loss of power will occur until the end of the third week has passed. Watkins (1949) has observed a second wave of paralysis in over 10 per cent of a series of cases, the author has seen two cases in which one upper limb was affected, the patient was allowed to be ambulant at the end of a week and further severe paralysis of both lower limbs developed a week after that.

At the end of the paralytic stage, any combination of paralysis from weakness of one or two muscles in one limb to complete quadriplegia may be present. The severity of the paralysis, fortunately for those extensively affected, is not directly related to the degree of recovery that may ultimately take place. For instance, one limb all of whose muscles are paralysed at the height of the acute illness may show a return of activity in every muscle after two weeks, while the equally affected opposite limb remains completely paralysed.

The end of the fourth week following the onset of the paralysis is a convenient time at which to make a detailed assessment of the residual paralysis and paresis. The phase of spectacular but irregular recovery is over and, from now on, muscle power increases in a more constant and predictable way.

Muscle testing

The importance of muscle testing has been stressed by Seddon (1954). Except in a few patients who still need continuous artificial respiration in a tank respirator, it should be possible to test the power of all the muscles or muscle groups shown in the muscle charts illustrated in Seddon's article and to grade their power according to the scale approved by the Nerve Injuries Committee of the Medical Research Council, or a modification of it (Table I). The modified scale makes the steps between successive grades more even by introducing an extra grade between Medical Research Council Grades 4 and 5 (normal power) and a more accurate prediction of recovery is possible.

TABLE I
GRADES OF MUSCLE POWER USED IN MANUAL TESTING
(Modified Medical Research Council Scale)

Grade 0	No contraction
Grade 1	Flicker or trace of contraction
Grade 2	Active movement with gravity eliminated
Grade 3	Active movement against gravity
Grade 4	Active movement against gravity and some resistance
Grade 5	Active movement against gravity and considerable resistance
Grade 6	Normal power (within the limits of manual assessment)

The results of the study of muscle recovery by muscle tests made every 2 months for the first year, and every 6 months for the succeeding two years in 149 patients are quoted by Sharrard (1955a).

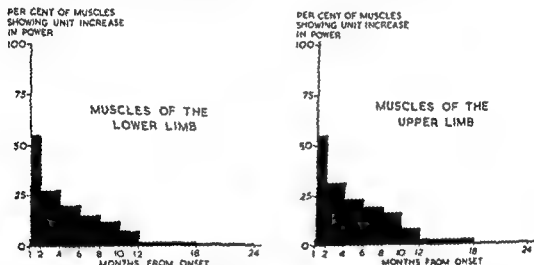


FIG 58—The rate of recovery in paretic muscles in the lower and upper limb
(B) courtesy of the Editor of the *Journal of Bone and Joint Surgery*

Recovery of paretic muscles

Paretic muscles, that is, muscles that are active but below normal power by clinical assessment, can confidently be expected to increase in power after the first month

At the twelfth month, recovery of individual muscles usually ceases. Further increase in power may result in a few muscles given intensive muscle training up to the end of the second year. After this, the only muscles in which any increase in power can occur are those in which the correction of a deformity at a joint allows a muscle previously working at a mechanical disadvantage to function again.

It must be emphasized, though, that two years does not mark the end of functional recovery, to which no final date can be given in any one patient.

All paretic muscles in an upper or lower limb make the same mean increase in power in the same way irrespective of their situation in the limb or their distance

permanently, and of those that do recover less than 50 per cent achieve more than a flicker of contraction.

It may be important, especially in the early months, to try to assess whether or not a paralysed muscle can recover. Some indication of the prognosis for a muscle can be obtained by examination of muscles supplied by the same spinal segment. Paralysis of all the muscles is an extremely bad sign; a special example of this is the limb that is completely paralysed or one that shows activity only in the intrinsic foot muscles. No muscle ever recovers in such a limb.

An even more specific guide to the future of a paralysed muscle is the state of its associated muscles (see Table VIII on p 89). When two or more of them are paralysed the prognosis is bad; when two or more are paretic or normal the prognosis is comparatively good.

CLINICAL DISTRIBUTION OF THE PERMANENT PARALYSIS

The limbs

The series of cases by Lovett (1915) showed an enormous preponderance of paralysis affecting lower limbs compared with upper limbs, and a slightly more frequent paralysis in left than in right upper limbs. In the same series the lower limbs were affected less than twice as often as upper limbs (Table III), and there was no

TABLE III
SITE AND GENERAL SEVERITY OF PARALYSIS IN THE LIMBS OF 149 PATIENTS

Site	No of cases	Severe	Moderate	Mild
Right upper limb	66	4	17	45
Left upper limb	60	10	14	36
Right lower limb	108	36	30	42
Left lower limb	103	32	27	44

statistically significant difference between the numbers of affected right and left upper limbs. The number of severely paralysed left upper limbs (10) was more than twice the number of severely paralysed right upper limbs (4). It is probable that this difference was due to the effects of inoculation against diphtheria or whooping cough which had been performed during the pre-paralytic phase in 8 children, all of whom suffered a severe paralysis of the inoculated limb which was the left upper limb in 7 cases and the right in 1 case.

Paresis and paralysis in the lower limb

At the end of the period of recovery, an affected limb shows a permanent pattern of paralysis. At first sight, the distribution appears to be quite haphazard and the pattern to differ in every case; but as early as 1913, Wickman noticed that certain muscles were paralysed more frequently than others. Several later writers, notably Lovett (1915, 1917) and Legg (1929, 1937) in studies of epidemics in Massachusetts, analysed the frequency of paralysis and paresis in the muscles of the lower limb and found a high incidence of paralysis in tibialis anterior, tibialis posterior, the long extensors of the toes and the peronei, a low incidence of paralysis but a greater combined total of paralyse and paresis were present in the quadriceps and the gluteal muscles.

An analysis of 2,464 lower limb muscles confirmed and extended these findings. The quadriceps, hip abductors and inner hamstring muscles lead in frequency of

PART I—ORIGINAL ARTICLES

Paresis and paralysis in the upper limb

All who have studied the distribution of the paresis and paralysis in the upper limb have found that the deltoid muscle leads in frequency of affection and of paralysis. Apart from this, there is little agreement in different series, probably because of the small numbers analysed in some cases.

There were 841 upper limb muscles in the series, and an analysis was made in the same way as for the lower limb. The deltoid muscle led in frequency of affection, followed by triceps and pectoralis major (Table VI). The least affected muscles were

TABLE VI
FREQUENCY OF AFFECTION OF 841 MUSCLES IN THE UPPER LIMB

Muscle	Number affected
Deltoid	94
Triceps	85
Pectoralis major	73
Infraspinatus	68
Latissimus dorsi	63
Thenar muscles	54
Elbow flexors	53
Pronators	45
Extensores pollicis	42
Interossei and hypothenar muscles	42
Wrist flexors	42
Extensor digitorum communis	41
Wrist extensors	40
Trapezius	39
Flexores digitorum	31
Flexor pollicis longus	29
Total	841

TABLE VII
INCIDENCE OF PARALYSIS AND PARESIS IN THE MUSCLES OF THE UPPER LIMB

Muscles (In order of frequency and paralysis)	Number paralysed	Number paretic	Ratio of paresis to paralysis
Thenar muscles	28	26	0.93
Deltoid	25	69	2.8
Interossei and hypothenar muscles	15	27	1.8
Triceps	15	70	4.0
Wrist flexors	14	28	2.0
Infraspinatus	11	54	3.8
Wrist extensors	11	29	2.6
Pronators	11	34	3.1
Latissimus dorsi	10	52	4.7
Elbow flexors	9	43	4.3
Extensores pollicis	9	33	3.6
Pectoralis major	8	64	7.0
Flexor pollicis longus	8	21	2.5
Extensor digitorum communis	5	33	4.1
Flexores digitorum	2	26	5.2
Trapezius	2	37	18.5
Total	195	646	

the long flexors of the digits. In frequency of permanent paralysis the deltoid muscle was second to the thenar muscles and was followed by the interossei and the triceps (Table VII)

The order of the *ratio of paresis and paralysis* differs from that of the frequency of affection and of paralysis. The intrinsic muscles of the hand (thenar and interosseous) are by far the most susceptible, followed by the muscles acting on the wrist. The deltoid muscle is only moderately susceptible, and trapezius and pectoralis major the least.

Associated paralyses

Mention has been made earlier of the existence of associated paralyses—muscles that tend to be paralysed or spared together. Table VIII lists them in the lower limb. Some of the muscles are of like function; for instance, the long toe extensors and peronei or the gluteal muscles. In other associations, such as those between the calf muscles and biceps femoris or between the quadriceps, hip adductors and hip flexors, there is no direct functional relationship and in a few instances, such as that between flexor and extensor hallucis longus, the muscles are antagonists. The absence of a strong association between agonist muscles such as the inner and outer hamstring muscles or between the long toe flexors and the intrinsic foot muscles is equally significant.

TABLE VIII
ASSOCIATED PARALYSES IN THE LOWER LIMB

(Muscles in heavy type are very strongly associated; those in normal type are strongly associated)

Muscle	Associated muscles
Hip flexors (psoas)	Quadriceps, adductors
Adductors	Quadriceps, adductors
Quadriceps	Quadriceps, adductors
Inner hamstring muscles	Quadriceps, adductors
Hip abductors (gluteus medius and minimus)	Quadriceps, adductors
Tensor fasciae latae	Quadriceps, adductors
Gluteus maximus	Quadriceps, adductors
Biceps femoris	Quadriceps, adductors
Calf muscles (triceps surae)	Quadriceps, adductors
Flexor hallucis longus	Quadriceps, adductors
Flexor digitorum longus	Quadriceps, adductors
Extensor hallucis longus	Quadriceps, adductors
Extensor digitorum longus	Quadriceps, adductors
Peronei	Quadriceps, adductors
Tibialis anterior	Quadriceps, adductors
Tibialis posterior	Quadriceps, adductors
Intrinsic foot muscles	Quadriceps, adductors

In the upper limb, associated paralyses of the same kind are found, for instance, between the deltoid muscle, the spinati and flexor carpi radialis, a complete analysis is still being worked out.

PATTERNS OF PARALYSIS IN THE LOWER LIMB

The patterns of paralysis that result from the division of a peripheral nerve at any level are clear cut and relatively constant. Except in partial nerve lesions, each muscle in the affected limb is either completely inactive or normal.

The position in poliomyelitis is very different. Paretic muscles of different grades of power lie side by side with paralysed or normal muscles without relation to the distribution of peripheral nerves and, at first sight, the disposition of the paralysis seems to be quite fortuitous. In a sufficiently large series of cases the same patterns of paralysis are repeated sufficiently often to suggest that a mathematical analysis would be worthwhile.

Method

Muscle charts of 500 lower limbs provided the material. The number of muscle groups analysed was 12, 6 above and 6 below the knee and they were rated as either

PART I—ORIGINAL ARTICLES

paralysed (Grades 0 and 1), or acting (Grades 2-6). With this simplification the number of theoretically possible patterns of paralysis in the lower limb is 4,096; if the muscles above or below the knee are taken independently, 64 combinations can occur in each limb segment. The incidence of each of these combinations can be expected from a random distribution of the 6,000 muscles was calculated and compared with the incidence observed in the 500 limbs.

Results—muscles below the knee

Of the 64 possible patterns of paralysis, 20 were found, 11 of them being major patterns and the remainder variants of them. Since it is the pattern of the paralysis in the muscles below the knee that determines the liability to deformity in the foot, especially in a child, the deformity to which each pattern predisposes is indicated below.

(1) Severe paralysis

(a) *Paralysis of all muscles below the knee (74 cases).*—This is the commonest pattern. In over 80 per cent of the cases it is associated with paralysis of all, or all but one, of the remaining muscles in the lower limb. The resulting deformity is negligible or at most a slight equino-varus due to the action of gravity.

(b) *Paralysis of all muscles below the knee except the intrinsic foot muscles (44 cases).*—In over 50 per cent of the cases it is associated with severe paralysis of muscles above the knee. The resulting deformity is a mild metatarsus varus and flexion of toes at the metatarso-phalangeal joints.

(2) Paralysis of inversion

(a) *Isolated paralysis of tibialis anterior (56 cases).*—In 42 cases this was the only paralysed muscle in the lower limb. When the tibialis anterior is the only muscle below the knee that is paralysed and one or more muscles above the knee are also paralysed, the quadriceps is always affected. The resulting deformity is sometimes a medial cavus (Pilcher, 1955) with depression of the head of the first metatarsal produced by the combined action of peroneus longus and an over-acting extensor hallucis longus; sometimes there is a mildly valgus forefoot, and in others no deformity at all.

(b) *Paralysis of tibialis anterior and posterior (55 cases).*—This frequent combination of paralysis may or may not be associated with paralysis of muscles above the knee; if such is the case, one or more of the quadriceps, adductors, or hip flexors are paralysed. The resulting deformity is usually a valgus foot of variable severity.

(c) *Paralysis of tibialis anterior and long toe flexors (23 cases).*—This is a slight variant of isolated paralysis of tibialis anterior. In 50 per cent of the cases these were the only two paralysed muscles in the limb.

(3) Paralysis of dorsiflexion

(a) *Paralysis of the tibiales and long toe extensors (12 cases).*—This differs from the last group in that the main effect is to cause a drop-foot. The resulting deformity is a valgus or equino-valgus foot.

(b) *Paralysis of the tibiales and long toe flexors and extensors (9 cases).*—This is a slight variant of the above group.

(4) Paralysis of dorsiflexion, inversion and eversion

(a) *Isolated action of the calf (triceps surae) and intrinsic foot muscles (23 cases).*—This is a further extension of the last pattern, in that there is paralysis of the tibiales, long toe flexors and extensors and peronei, it is titled in respect to the muscles that are acting to draw attention to the severe and intractable deformity that always occurs. The tendo achillis in the absence of the peronei is a slight inverter of the heel; in time, a fixed inversion deformity of the heel develops. The tendon acts in the fashion

PART I—ORIGINAL ARTICLES

(10) *Isolated paralysis of the long toe flexor muscle (6 cases)*

This is a rare pattern which does not give rise to significant disability or deformity. As a rule there are no other paralysed muscles in the lower limb.

(11) *No paralysis in muscles below the knee*

In 110 cases no muscles below the knee were paralysed. In many there was so relative weakness of one or other muscle group corresponding to one of the patterns of paralysis already described and showing a liability to the same deformity in milder way. In more than 50 per cent no muscles above the knee showed complete paralysis.

As important as the existence of patterns of paralysis is the finding that, in the 500 limbs, 44 possible combinations of paralysis below the knee never occurred and that most of the patterns recorded above occurred more frequently than would be expected. Combinations in which the intrinsic foot muscles are paralysed are particularly uncommon unless two or more of the other muscle groups are paralysed are also paralysed, and combinations in which the tibiales are acting in the presence of paralysis of other muscle groups are infrequent.

Results—muscles above the knee

Compared with the ankle and foot, the hip and knee joints, if correctly treated, are less subject to secondary deformity due to muscle imbalance; on the other hand, paralysis in muscles above the knee leads to greater functional disability. The classification of patterns of paralysis above the knee is therefore based on the main functional disability that results in each pattern.

(1) *Severe paralysis*

(a) *Paralysis of all muscles above the knee (70 cases)*—As in muscles below the knee, the commonest pattern is that in which all the muscles are paralysed. In 60 per cent of the cases all, or all but one, of the muscles below the knee were also paralysed.

Ability to walk depends on the activity of the trunk musculature, particularly of the quadratus lumborum, and on the state of the other limbs.

(b) *Isolated action of the adductors (6 cases)*—An uncommon pattern. The adductors are seldom stronger than Grade 2 and there is nearly always an associated severe paralysis in muscles below the knee.

Functional ability is the same as if there was a complete paralysis of all the muscles above the knee.

(c) *Isolated action of the hip flexors (13 cases)*—A pattern also associated with severe paralysis in muscles below the knee. Functional ability is slightly better than in the previous patterns because the limb can be swung forwards.

(d) *Isolated action of the gluteus maximus (19 cases)*—This pattern is often associated with active calf and intrinsic foot muscles and with active external rotators of the hip. Unfortunately, the spared gluteus maximus is seldom more powerful than Grade 2 and function is very little better than in a completely paralysed hip and thigh.

(e) *Isolated action of gluteus maximus and hamstring muscles (5 cases)*—The gluteus maximus in this pattern is usually moderately strong (Grade 3 or 4) and, with the help of the hamstring muscles, hip extension is fairly powerful. The paralysis below the knee is often a mild one, and, if the calf muscle is also strong, extension of the knee when the foot is on the ground may be good enough to allow a caliper to be discarded in an adult.

(f) *Isolated action of hip flexors and quadriceps (3 cases)*—This pattern, though rare, is notable for its liability to produce genu recurvatum even though splints or calipers are used in an attempt to prevent it.

(2) *Paralysis of knee extensors*

(a) *Isolated paralysis of the quadriceps (15 cases).*—An infrequent pattern, but the second most common isolated paralysis in the lower limb as a whole (6 cases). The associated paralysis below the knee is almost always mild, often only in the tibialis anterior.

Function is remarkably little impaired, and except in a child, in whom a caliper may be necessary to prevent deformity at the knee, external support may be unnecessary for ordinary walking, provided that the muscles can lock the knee in extension.

(b) *Paralysis of quadriceps and adductors (13 cases).*—This pattern differs from the last in that the remaining muscles above the knee are generally a little weaker, and average about Grade 3 in strength. For this reason, a caliper to stabilize the knee is more often required.

(3) *Paralysis of knee flexors and extensors*

(a) *Paralysis of quadriceps and inner hamstring muscles (7 cases), and (b) of quadriceps, inner hamstring muscles and adductors (8 cases).*—The functional disability is similar to that in the previous group, though a little more severe because the other muscles above the knee and below it are moderately affected in most cases.

(4) *Paralysis of hip flexors and knee extensors*

(a) *Paralysis of hip flexors and quadriceps (5 cases)*—In this pattern, the action of "pushing off" by extension of the hip and locking at the knee is retained, but the inability to swing the limb forward and to extend the knee actively produces an ugly gait. Since the associated paralysis below the knee is often mild, the functional ability can be fairly good in spite of the poor gait.

(b) *Paralysis of hip flexors, quadriceps and adductors (4 cases), of hip flexors, quadriceps, and inner hamstring muscles (5 cases), and of hip flexors, quadriceps, adductors and inner hamstring muscles (11 cases).*—Function in these three patterns is like that in the previous pattern. The paralysis below the knee is usually more severe, and, in the absence of adequate calf muscles, locking of the knee in extension is difficult. A caliper to stabilize the knee may therefore be needed.

(5) *Paralysis of hip abduction or hip extension, or both*

(a) *Isolated paralysis of hip abductors (7 cases), and of hip abductors and hamstring muscles (3 cases)*—In both patterns, the disability, apart from a Trendelenburg gait, is not great. Paralysis of the hamstring muscles in the presence of an active quadriceps is very likely to produce a genu recurvatum deformity in a child.

(b) *Paralysis of hip abductors, hamstring muscles and quadriceps (4 cases).*—The disability at the hip is the same as in the two preceding patterns; the quadriceps paralysis added to it gives an unstable limb for which a caliper is usually required.

(c) *Paralysis of hip abductors, gluteus maximus and biceps femoris (7 cases).*—Paralysis of these muscles is associated with patterns of paralysis below the knee in which the calf and long toe flexor muscles are paralysed. Although the intact quadriceps and hip flexors make it possible to walk without a full caliper, a Trendelenburg gait is inevitable, and if the abdominal muscles are weak or paralysed an ugly increase in lumbar lordosis develops. If the acting hip flexors and adductors are strong and the small rotators of the hip paralysed, the hip may dislocate; this tendency is aggravated if the neck of the femur develops a valgus deformity (Blundell Jones, 1954).

(d) *Isolated action of hip flexors and adductors (6 cases).*—The problem is the same, but rather greater than the last pattern. The paralysis below the knee is usually severe and a caliper is essential. Dislocation of the hip also occurs in this pattern.

(6) *Paralysis of hip abduction and adduction*

(a) *Paralysis of hip abductors and adductors and quadriceps (3 cases), and of hip abductors and adductors, quadriceps and hamstring muscles (2 cases).*—The associated

paralysis below the knee is moderately severe. Functional ability with an ischial-bearing caliper is usually fairly good

(7) *Paralysis of hip flexion and abduction and knee extension*

(a) *Paralysis of hip flexors and abductors and quadriceps (1 case), and of hip flexors and abductors, quadriceps and inner hamstring muscles (3 cases).*—Rare patterns in which there is considerable disability, the active gluteus maximus and adductor muscles being inadequate to allow walking without the aid of a caliper.

(8) *Isolated paralyses*

(a) *Isolated paralysis of hip adductors (4 cases), of biceps femoris (7 cases), and of hip flexors (3 cases).*—None of these produce any very significant disability.

(9) *No paralysis in muscles above the knee (265 cases)*

As in the muscles below the knee, there were many cases with a weakness in one or two muscles, particularly in the quadriceps or the hip abductors. In general, the less the paralysis above the knee, the milder it was below the knee.

Over 50 per cent of the combinations of paralysis that could theoretically exist never occurred in the 500 limbs. Combinations in which the gluteus maximus is paralysed are rare unless three or more of the other muscles above the knee are also paralysed, and combinations in which the quadriceps is acting when the other muscles are paralysed are infrequent.

The number and variety of patterns recorded above may perhaps be rather bewildering to those whose contact with cases of poliomyelitis is limited to a few in every year. Nevertheless, the eleven groups of patterns below the knee and nine above it certainly do not amount to more than all the combinations of paralysis that can result from lesions in peripheral nerves from the level of the cauda equina to the digital nerves of the toes.

THE PATHOLOGICAL BASIS OF THE MUSCLE PARALYSIS

The analysis of affected limb muscles (Lovett, 1915) showed, as do Tables IV and VI, a tendency for muscles nearest the trunk to be more frequently involved than the distal ones. He therefore concluded that differences in the function and size of proximal and distal muscles were responsible. If this were true, the same muscles should suffer paralysis in the same order of frequency, but Tables V and VII show a completely different order.

The observation by Russell (1947), that exercise in the pre-paralytic stage of poliomyelitis increases the severity of the paralysis, has given rise to further speculation on the relationship between fatigue in individual muscles and their liability to paralysis. While a limb as a whole may suffer more severely, it cannot be said that the muscles in the upper half of any of the Tables IV–VII are singled out by fatigue in ordinary activities, nor can dissociated paralysis in muscles of the same type, size and function, such as the inner and outer hamstring, be explained by such a mechanism.

As Skinhoj (1949) observed in a similar study, there is no quality of muscle such as size, function, position in the limb or phylogenetic development that can satisfactorily explain all the features of the clinical distribution of the paralysis, nor does it correspond to the innervation of muscles by peripheral nerves. There remains the possibility that it may be related to the nature of their innervation from the motor nerve cells of the anterior horn of the spinal cord.

SEGMENTAL INNERVATION IN RELATION TO AFFECTATION OR PARALYSIS OF MUSCLES

Evidence of a relationship between muscle affection and spinal segmental nerve supply is given by curves, derived from Tables IV and VI, of the *segmental incidence*

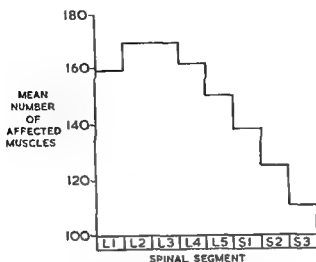


FIG. 60 —The segmental incidence of affection of muscles in the lower limb

(By courtesy of the Editor of the Journal of Bone and Joint Surgery)

of muscle affection. In the lower limb (Fig. 60) the highest incidence is found in the second and third lumbar segments, below this level, there is a uniform decrease in the incidence of affected muscles that progress to a spinal segment supply

the

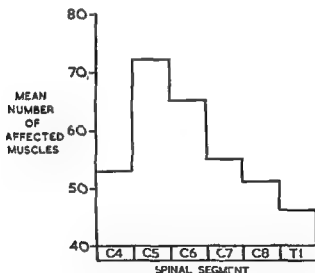


FIG. 61 —The segmental incidence of affection of muscles in the upper limb

(By courtesy of the Editor of the Journal of Bone and Joint Surgery)

THE SPINAL CORD IN THE NORMAL AND POLIOMYELITIS

Attempts by earlier authors (Lovett, 1915, Skinhoj, 1949) to explain their clinical findings in terms of spinal cord lesions were hampered by the paucity of information concerning the localization of function in the motor cells in man and by the incomplete accounts of the sites of destruction of these cells in poliomyelitis.

In 1950, a study of normal and poliomyelitic spinal cords was begun; the results,

PART I—ORIGINAL ARTICLES

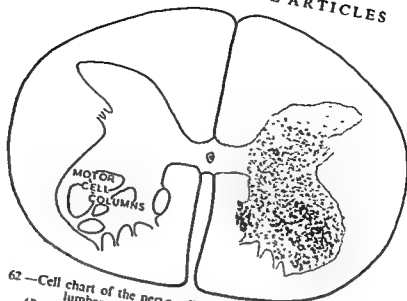


FIG 62—Cell chart of the nerve cells in the grey matter of the third lumbar segment of a normal spinal cord.
(By courtesy of the Editor of the *Journal of Bone and Joint Surgery*)

a summary of which will be given here, account for all the clinical phenomena. muscle affect, paralysis, association of paralysis and patterns of paralysis described above.

Method of study

The principles underlying the study of the spinal cord in poliomyelitis are simple. Spinal cords were obtained from seven patients who had died at intervals varying between three months and eight years after the onset of the disease. The level of

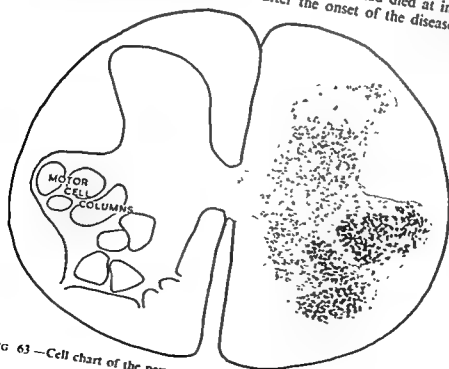


FIG 63—Cell chart of the nerve cells in the grey matter of the fifth lumbar segment of a normal spinal cord.
(By courtesy of the Editor of the *Journal of Bone and Joint Surgery*)

PART I—ORIGINAL ARTICLES

The second and third lumbar spinal segments were the most frequently and extensively attacked in all the cords. Segments caudal to this were less often affected, the third and fourth sacral segments being especially likely to be spared. A similar segmental incidence of motor cell destruction has been noted by others (Horanyi-Hechst, 1935; Peers, 1943; Elliott, 1945, 1947).

Destruction was found not to be diffuse but localized in discrete foci of varying length and width with interposed lengths of grey matter of more normal cell content. An example of this is shown in Fig. 64, which represents the longitudinal distribution of the lesions in one of the spinal cords, reconstructed from more than 300 cell charts.

In the transverse plane the centre of the anterior horn appeared to be the most vulnerable area at most segmental levels. The fifth lumbar segment, in which the anterior

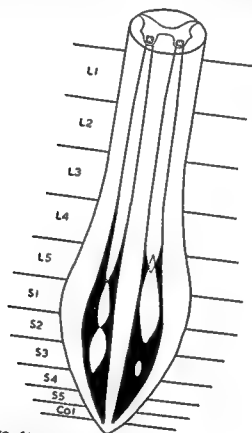


FIG 64—A longitudinal analysis of the destruction of motor cells in the lumbo-sacral cord in a case of poliomyelitis with a moderate bilateral paralysis of the lower limbs. Regions shown in black contain residual motor cells. Note the complete absence of cells in the upper lumbar spinal segments and the focal loss in the lower lumbar and sacral segments (By courtesy of the Editor of the *Journal of Bone and Joint Surgery*).

horn has its greatest transverse area, demonstrated this central loss very clearly; the example shown in Fig. 65 was typical of that found in many cell charts in the poliomyelitic cords at this level.

Motor cell destruction was always much more severe than would have been expected. One case in which there had never been any demonstrable weakness in any muscle in the lower limb had suffered losses up to 40 per cent of the normal

number of cells in some cell columns. Far from there being any evidence that residual motor cells were functionally inactive, it was surprising to discover how small a proportion of cells had been required to produce a useful contraction in the muscle they supplied. The residual power of a muscle was found to be closely related to the proportion of remaining motor cells that supplied it (Table IX).

TABLE IX
RELATIONSHIP BETWEEN MUSCLE POWER AND RESIDUAL MOTOR CELLS IN THE SPINAL CORD

Muscle power (modified Medical Research Council scale)	Percentage of residual motor cells
0	0-2
1	2-3
2	3-5
3	5-10
4	10-20
5	20-40
6	over 40

Relationship between the distribution of the paralysis and the destruction of motor nerve cells

Affection of muscles
The segmental incidence of muscle affection (Fig 60) derived from the analysis of the clinical material agrees exactly with the general distribution of motor cell destruction described above. Since the upper lumbar spinal segments supply muscles in the region of the hip and thigh, while the lower lumbar and sacral segments generally supply the muscles of the leg and foot, it is easy to see why there is, apparently, a greater incidence of affection in proximal than in distal muscles in the limb. It is interesting to note that the hip muscle that derives its main supply from the

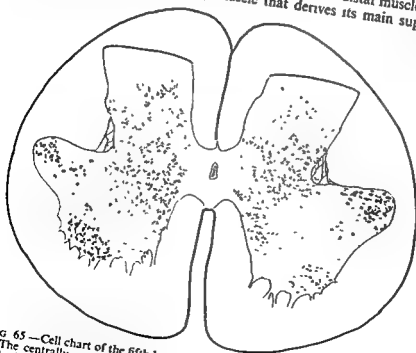


Fig 65 — Cell chart of the fifth lumbar segment of a poliomyelitic spinal cord. The centrally situated motor cell columns have been severely affected on both sides (Compare with the normal in Fig 63)
(By courtesy of the Editor of the Journal of Bone and Joint Surgery)

sacral segments—the gluteus maximus—is less frequently affected than other hip muscles (Table IV). This is also true of the small external rotator muscles of the hip, though they are not shown in the Table.

The findings in the spinal cord also account for the large number of paralyses found in muscles such as tibialis anterior, tibialis posterior and the long flexor and extensor muscles of the toes. In Table X the ratios of paresis to paralysis in individual muscles are compared with the lengths of the motor cell columns that supply them. Muscles supplied by short columns of cells are the most frequently paralysed; those supplied by long columns are most likely to be paretic.

Plate II illustrates the probable mechanism responsible for this finding. A focus of motor cell destruction that severely affects the fourth and the upper part of the fifth lumbar spinal segment destroys almost all of the motor nerve cells that supply the tibialis anterior and posterior. All other muscles are left with a proportion of residual motor cells sufficient to maintain normal power as judged by clinical examination.

TABLE X
THE RELATIONSHIP BETWEEN LENGTH OF CELL COLUMN AND THE RATIO OF PARESIS TO PARALYSIS IN MUSCLES IN THE LOWER LIMB

Muscle	Ratio of paresis to paralysis	Approximate length of motor cell column (millimetres)
Tibialis anterior	0.47	8
Flexor digitorum longus	0.52	8
Tibialis posterior	0.57	8
Flexor hallucis longus	0.58	8
Extensor hallucis longus	0.69	9
Extensor digitorum longus	1.06	10
Peronei	1.10	10
Calf muscles (triceps surae)	1.26	14
Biceps femoris	2.03	14
Hip abductors	2.78	16
Intrinsic foot muscles	2.87	15
Inner hamstring muscles	2.90	20
Tensor fasciae latae	2.92	16
Quadriceps	3.00	22
Gluteus maximus	3.30	17
Hip adductors	3.50	22
Hip flexors	3.67	23

All the features of the distribution of paresis and paralysis are satisfactorily explained in terms of lesions in the spinal cord. All the evidence is against a primary cause in the muscles themselves. If it were true that the distribution of paralysis was related to factors peculiar to certain muscles, movements or activities, evidence of it would be found in the disposition of cell destruction in the spinal cord. In fact, the focal loss of cells is completely independent of the boundaries of any one cell column, parts of cell columns are frequently obliterated in vertical or transverse planes. For the same reason, the implication of higher centres as primary factors in the localization of the paralysis is inadmissible.

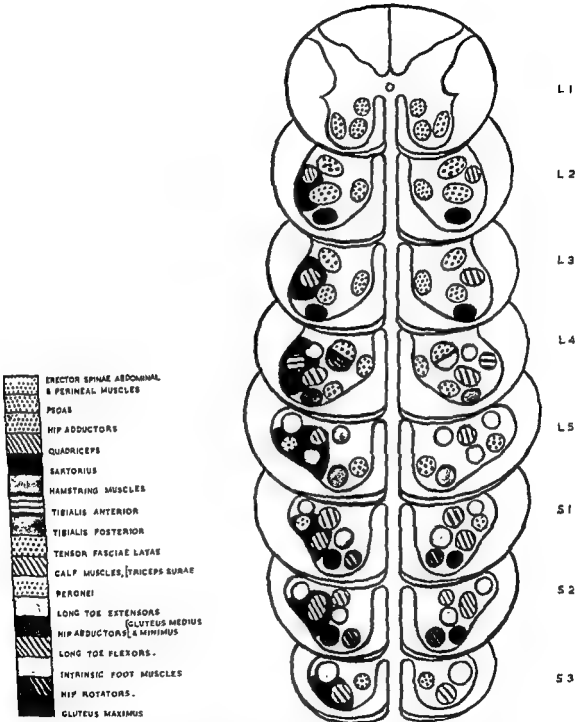
Associated Paralyses

When the whole of the motor column that supplied a muscle has been destroyed, it is likely that one or more adjacent motor columns that occupy the same length of spinal cord will be completely destroyed or severely affected. This is reflected in the clinical distribution of muscle paralysis. For instance, the columns that supply extensor hallucis longus, extensor digitorum longus and peronei lie next to each other and occupy approximately the same length of spinal cord (Plate I). Paralysis of one of these muscles is, therefore, frequently associated with paralysis of the other two

PLATE I

RIGHT SIDE

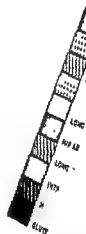
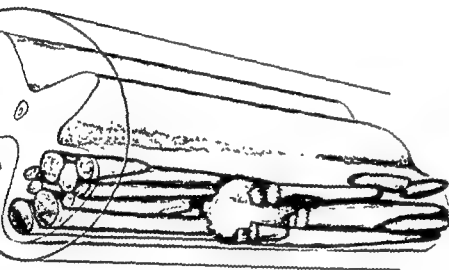
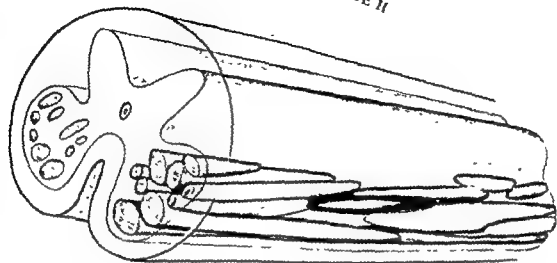
LEFT SIDE



The representation of the lower limb muscles in the motor cell columns of the lumbo-sacral spinal cord. The groupings of the columns are those that are the most characteristic in each spinal segment. Areas shown in black are those most liable to be affected by poliomyelitis.

(By courtesy of the Editor of the Journal of Bone and Joint Surgery)

PLATE II



cell columns of the third, fourth and fifth lumbar segments of the spinal
 cell columns are shown. the two columns shown in colour are
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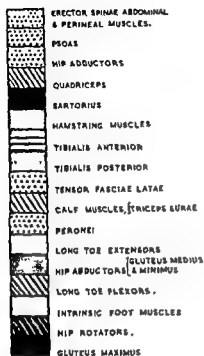
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PLATE III

RIGHT SIDE

LEFT SIDE



A representation of motor cell loss in the lumbo-sacral spinal cord in poliomyelitis. On the right side all the cells in the second, third and fourth lumbar segments have been destroyed. Cell columns for the quadriceps, hip adductors, sartorius and tibialis anterior have disappeared, these muscles will be paralysed. The psoas and tensor fasciae latae retain a portion of their cell columns and will be paretic. On the left side the second, third, fourth and fifth lumbar segments have been destroyed. The cell columns for the quadriceps, hip adductors, sartorius, tibialis anterior and tibialis posterior have disappeared, these muscles will be paralysed. The hip adductors, semimembranosus, long toe extensors and peronei retain a portion of their cell columns and will be paretic.

(B) courtesy of the Editor of the Journal of Bone and Joint Surgery

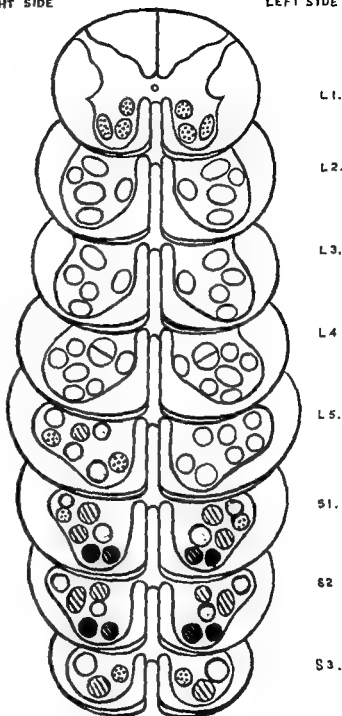
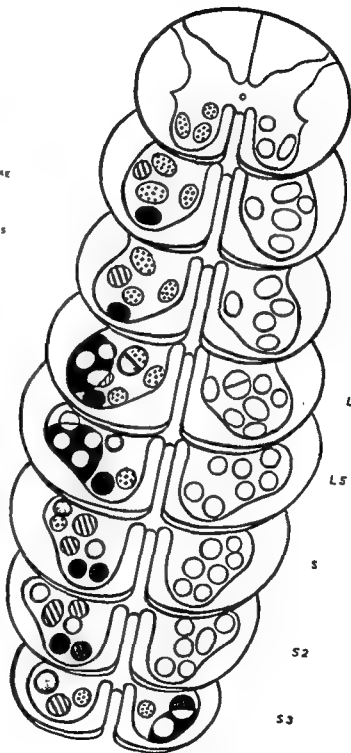
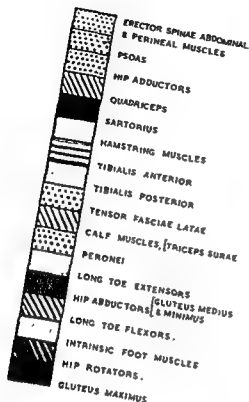


PLATE IV

RIGHT SIDE

LEFT SIDE



A representation of motor cell loss in the lumbo-sacral spinal cord in poliomyelitis. On the right side a partial lesion in the fourth and fifth lumbar segments has destroyed the cell columns for the tibialis anterior and tibialis posterior. All other muscles have retained a high proportion of their cells and the muscles concerned will not be clinically affected. On the left side all the cells of the third sacral segment have been destroyed. Only a portion of the column for the intrinsic muscles of the foot remains. The clinical result will be a flail lower limb in which only the intrinsic muscles of the foot are active.

(By courtesy of the Editor of the Journal of Bone and Joint Surgery)

POLIOMYELITIS: DISTRIBUTION OF PARALYSIS

(Table VIII). Conversely, absence of paralysis in one muscle is likely to be associated with absence of paralysis in the others.

Unusual associations, like that between the calf muscles (triceps surae) and biceps femoris, can be accounted for in the same way and would, indeed, be expected to occur since their motor cell columns are so closely associated. The factor common to all strongly associated pairs of muscles is that their motor cell columns lie adjacent to one another and their segmental levels of supply correspond or overlap. With the knowledge of the localization of function in the motor cell columns thus has been established above, it should be possible to deduce from the level of the paralysis in the muscles of any lower limb the approximate site and extent of lesions in the spinal cord, though not with such ease as in the diagnosis of a lesion in a peripheral nerve. Difficulties arise because, as indicated in Table IX, a muscle is not paralysed unless the whole of its motor cells column has been affected. Even a residue of 10 per cent of intact motor cells may permit substantial activity in a muscle, and these intact cells may lie at the upper end, in the middle, or at the lower end of the cell column.

There is another important difference between the analysis of peripheral nerve lesions and poliomyelitic lesions. Whereas lesions in peripheral nerves are much more often complete than partial in the transverse plane, lesions in the spinal cord frequently only involve part of the width of the grey matter at any given segmental level.

The distribution of muscle paralysis that might be expected to result from the existence of total or partial lesions of varying longitudinal extent in the grey matter of the lumbo-sacral spinal cord can nevertheless be worked out, and, conversely, all the common combinations or patterns of paralysis in poliomyelitic lower limbs can be explained in terms of one or more foci of motor cell destruction.

Plate I shows the position and size of cell columns for the lower limb muscles in the lumbo-sacral cord. The regions of the anterior horn that are shown in black in each segment are those most likely to be affected in partial lesions in the transverse plane. If all the cells in the second, third and fourth lumbar segments are destroyed, only the quadriceps, hip adductors, sartorius and tibialis anterior will be paralysed; the psoas and tensor fasciae latae will be paretic, but other muscles will be normal (Plate III, right side). The pattern corresponding to this loss is 2 b in muscles above the knee and 2 a below the knee (See pp 90-94). Should the destruction involve the fifth lumbar segment as well, the tibialis posterior will also be paralysed, the hip abductors and semimembranosus will be severely paretic and the long toe extensors and peronei mildly paretic (Plate III, left side). The pattern is then 2 b above and 2 b below the knee.

The common isolated paresis of the tibialis anterior (pattern 2 a) results from a partial lesion in the lower part of the fourth and the upper part of the fifth lumbar segments (Plate II). When the tibialis anterior and tibialis posterior are both paralysed (pattern 2 b), there is a partial lesion extending throughout both segments (Plate IV, right side).

An extensive lesion that destroys all the motor cells in the lumbo-sacral segments gives rise to a lower limb in which only the intrinsic muscles of the foot and the peroneal muscles are active (Plate IV, left side). This corresponds to pattern 1 a above and 1 b below the knee.

These few examples demonstrate how, by various combinations of destructive lesions in the grey matter of the spinal cord, the distinctive patterns of paralysis in poliomyelitis may be explained.

THE PRACTICAL APPLICATION OF THESE FINDINGS

The clinical and pathological results recorded here can be applied in the management of all stages of poliomyelitis.

Diagnosis

In the diagnosis of poliomyelitis, at an interval after the acute stage, or when no febrile illness has been observed, the distribution of the paralysis alone may differentiate it from other lower motor neurone diseases. The paralysis in poliomyelitis is rarely precisely symmetrical. So frequently are the hip abductors, quadriceps or tibialis anterior affected that absence of paresis or paralysis in any of them in the presence of paralysis in other muscles in the lower limb makes a diagnosis of poliomyelitis unlikely. By contrast, in peroneal muscular atrophy the muscles most frequently affected in the early stages of the disease are the intrinsic muscles of the feet and peronei, a combination of paralysis rarely seen in poliomyelitis.

Aparalytic poliomyelitis

The quantitative relationship between the loss of motor nerve cells and the residual power in muscles is particularly important in cases regarded as aparalytic in the acute stages of poliomyelitis. Although there may never have been any clinical paralysis, a considerable proportion of motor cells may have been damaged or destroyed. The nerve supply to some muscles, especially those supplied by short cell columns, may have been diminished by up to 60 per cent. Patients without any paralysis are frequently allowed to walk within two or three weeks of the onset of the major illness. It is known that over-stretching or over-fatigue can occur in muscles such as the hip abductors and tibialis anterior and may result in deterioration in power (Lovett, 1915, 1917; Sharrard, 1955a). Paresis, previously undetectable, may be revealed later by the development of a limp or a valgus foot. It is probably wise, therefore, not to allow the resumption of full activity in an aparalytic case at too early a date, and to continue to look for evidence of paresis over a period of not less than six months.

Prognosis

Table II can be used to assess the prognosis in paretic muscles up to the sixth month and Table VIII to indicate the possibility of recovery in paralysed muscles in the early months. After the sixth month it is unfair to patient and physiotherapist to continue specific treatment to paralysed muscles that will never recover any useful power.

Convalescent stage

The results can be used to aid in planning the treatment of the paralysis in a limb. For instance, in an adult, a caliper may be needed to give stability to the knee (in a child it may be required, in addition, to prevent deformity). In an adult lower limb in which the quadriceps acts at Grade 2 four months after the onset of the paralysis, it would be reasonable to postpone the prescription of a caliper in the expectation of recovery in that muscle to a level (Grade 3) sufficient to give stability to the knee joint. In another limb in which the quadriceps is completely paralysed, the pattern of paralysis is probably that illustrated in Plate IV. Treatment should be planned in the expectation that the quadriceps will remain paralysed and a caliper should be prescribed.

Muscle imbalance

It is widely believed that if there is inequality of muscle action at a joint, as, for example, when the triceps surae is paralysed to Grade 1 and the dorsiflexors of the ankle are acting at Grade 3, the progress of recovery may restore the balance, the weaker muscles being able to "catch up" with the stronger ones. Unfortunately, this never occurs, for both muscle groups recover at the same rate and to the same degree, maintaining the disparity between each other. The situation is even worse when one

of the muscles is paralysed and remains so; the paretic muscle increases in strength and the disparity between them is made worse.

Anticipation of deformity

After the sixth month the pattern of paralysis is well established; in most cases, it can be placed in one or other of the subdivisions already described and the cell loss that has occurred in the spinal cord can be visualized. Where there is an imbalance of loss of balance between opposing muscle groups, the appropriate deformity must be anticipated. The reserve capacity of the different individuals varies in different individuals.

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ACKNOWLEDGEMENT

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THE TREATMENT OF RECTAL PROLAPSE

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Since the earliest days prolapse of the rectum has excited the interest and taxed the ingenuity of surgeons and until the last century it was treated by fanciful ointments and curious devices designed to retain the bowel in place. The condition may be *partial or complete*, the first indicating a prolapse of mucous membrane only outside the anal orifice; the second a prolapse of the whole thickness of the rectal wall.

PARTIAL PROLAPSE

This may occur in infancy, when prolapse may also be complete; in adult life, when it may seem to be little more than an exaggerated degree of pile prolapse; or in the elderly, when, particularly in women, it may be associated with a lax sphincter and some degree of incontinence.

Prolapse in infancy

More cases occur during infancy than at any other age. It is said that the sacral curve is less marked in the child and the rectum less securely attached to the front of the sacrum. Chronic diarrhoea, loss of weight and debilitating diseases are all regarded as contributing causes but in the majority of cases the condition probably results from a child with irregular bowel habits or constipation being allowed to sit upon a chamber with periodic straining for a prolonged period.

Treatment

The mother should be instructed to give the child a diet with plenty of roughage and ensure a regular bowel routine after breakfast with the aid of liquid paraffin or milk of magnesia. If the prolapse appears it must be replaced at once. If it is of any size, or the mother appears unable to handle the situation, the child should be admitted and initially its bowels may be opened lying on its side with the aid of suppositories or small enemas. It is seldom that the discipline of a children's ward does not cure the condition but if conservative measures have failed, scattered high submucous injections of carbolic oil may be given or the rectal mucosa lightly cauterized by three or four linear incisions carried out under anaesthesia. After both these measures, which are designed to fix the redundant mucosa to the underlying muscle wall, the child should be retained in hospital for a fortnight under the same conservative measures.

Partial prolapse in adults

There are two main types of this condition in adults and the distinction between them is important. In the one the prolapse is associated with normal sphincter tone; in the other the sphincter is lax and there is frequently some degree of incontinence.

Mucous prolapse with a normal sphincter

The majority of these cases occur in elderly women and when it occurs in men it may be associated with prostatic obstruction. The condition is similar to haemorrhoids

with a severe degree of prolapse. There is seldom much pain but the patient finds it impossible to avoid staining the undergarments and occasionally the mucous leak may be responsible for ■ pruritus. Palliative treatment by high submucosal injections may be tried but operation gives quicker and much more satisfactory results. Age and general condition need seldom be regarded as a bar to operation, for if desirable it can be performed under a local anaesthetic. The operation consists in picking up the redundant mucous membrane in the three main pile areas, incising the mucocutaneous junction and transfixing each portion as in a pile operation. While it is desirable to remove sufficient, it is important not to strip up the pedicles too high or scarring may result in a stricture. The after-treatment includes the regular use of an anal bougie until all granulating areas have healed.

Mucous prolapse with anal incontinence

These cases constitute, perhaps, the most difficult problem in rectal prolapse. The patient's primary complaint is usually of the incontinence and not of the prolapse. The incontinence varies; it is not complete but as the occasional accident becomes more frequent the patient is never certain whether the rectum will leak or not. There is a patulous anus with a very poor sphincter tone. The anus can be closed voluntarily against the passage of a finger but once the voluntary contraction is over it again relaxes. A ring of mucosa descends on straining but the prolapse is seldom marked and the condition does not seem to be a stage in the development of complete rectal prolapse.

Gabriel (1948) has described the shortened anal canal that is found in these patients and the appearance of the mucous membrane almost contiguous to the anal verge. The majority of these patients are elderly women but childbirth seems to play no part in the history and there is seldom evidence of perineal damage. Gabriel regards the condition as due to failure of normal sympathetic control of the internal sphincter, caused possibly by fatigue and exhaustion through purgation over many years. Whatever the cause it is a most difficult condition to treat.

Treatment

Excision of the mucosal prolapse is not likely to benefit the patient if the sphincter is lax and indeed it must be recognized that while this type of case may improve considerably under treatment it cannot be completely cured. Initially the best course is to admit the patient to hospital, treat her with scattered high mucosal injections

injected in the perianal tissues. There is little risk in the operation and in frail or elderly patients it may be of great benefit

COMPLETE RECTAL PROLAPSE

Though the condition is actually more common in children, such cases seldom require more than the conservative or minor operative measures already outlined. In adults the treatment is much more difficult. It is said that complete rectal prolapse was not uncommon in concentration camps during the last war when loss of weight, muscular weakness and dysentery were probably the predisposing factors. Under ordinary circumstances the condition is much more common in women than in men, though again childbirth or perineal injury do not seem to be the cause.

Conditions present in complete rectal prolapse

Normally the rectum lies in the curved hollow formed by the sacrum, the coccyx and the extension forwards from the coccyx of the central raphe of the levator ani



FIG. 66.—Rectum outlined by barium in a normal female in the erect position demonstrating its adherence to the sacral curve and the almost horizontal position of the rectum from the coccyx forwards to the anal canal.

(Reproduced by courtesy of the Editor of Proc R Soc Med)

FIG. 67.—The normal position of the rectum following the sacral curve demonstrated by a barium enema in the knee-elbow position.

(Reproduced by courtesy of the Editor of Proc R Soc Med)





FIG. 68 —Film in the knee-elbow position of the rectum and vagina outlined by barium in a patient suffering from complete rectal prolapse. (Tip of coccyx marked.) The rectum is widely separated from the sacro-coccygeal curve.

(Reproduced by courtesy of the Editor of Proc. R. Soc. Med.)

(Figs. 66 and 67) In a normal female with a good pelvic floor, standing erect, a lateral view after a small barium enema shows that the last part of the rectum is almost horizontal in its direction as it passes forwards to the levator hiatus. The vagina lies almost horizontally above it and the cervix is vertically over the coccyx. The rectum

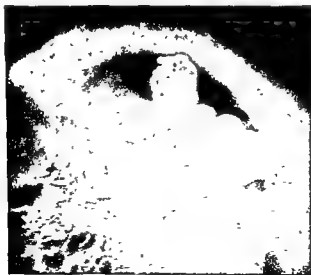


FIG. 69 —Film in the knee-elbow position of the rectum

is retained in its position in spite of variations in intra-abdominal pressure by this curve, which permits only a small part of the bowel to lie directly over the levator hiatus, by the fatty tissue around it containing arteries, veins, lymphatics and sympathetic nerve fibres, possibly by condensations of pelvic fascia, though some observers deny their existence, and most important of all by a strong levator ani muscle.

The peritoneum

If laparotomy is performed on a female suffering from complete rectal prolapse, and the interior of the pelvis inspected in a high Trendelenburg position, certain



FIG. 70. Film in the posterior view of the pelvis after laparotomy.

features are invariably present. It may be argued whether they are cause or effect but their recognition is essential if operative treatment is to be successful. Instead of lying closely against the sacrum the rectum retains a mesentery, usually short but occasionally up to 2 inches in length. This mesentery is attached loosely towards the left side of the sacrum. If it is pushed to the left the whole of the sacral concavity can be seen covered by peritoneum. The rectum does not lose its mesentery or become attached posteriorly until the sacrococcygeal region is reached and even here its attachment is loose. This curious attachment of the rectum can be demonstrated by lateral x-rays of the patient taken in the knee-elbow position and standing erect after a small barium enema (Figs. 68-70). The central part of the pouch of Douglas is particularly deep and passes downwards like a hernial sac between the rectum and the posterior vaginal wall almost to the levator ani (Fig. 71). Most of the posterior vaginal wall is now covered by peritoneum and there is little left of the normal recto-vaginal septum. If pressure is made with a finger on the rectal wall at the bottom of

the pouch of Douglas, it can be inverted through the anal orifice without difficulty. Moschowitz (1912), who gave the first accurate account of the findings in complete rectal prolapse, regarded this deep peritoneal pouch as a true hernia caused by the giving way of the pelvic fascia at this point, but more recently Berglas and Rubin (1953) concluded that there was no evidence of any real fascial sheaths around and between the pelvic organs.

The lateral rectal stalks

These are condensations of connective tissue on either side of the lower rectum, containing fat, vessels, nerves and lymphatics; they are believed to play a part in maintaining its position. In complete rectal prolapse these are loose and attenuated.

The fascia of Waldeyer

It is probable that this is the only true fascia in the pelvis. Lying just above the levators it is fused posteriorly to the front of the sacrum and is attached to the rectum around the ano-rectal region, where the rectum itself passes through the levator hiatus. It is only posteriorly and laterally that this fascia is of any substance. Anteriorly it is thin and not easy to distinguish and it is difficult to believe that operations for rectal prolapse that aim at suturing the fascia in this region can be effective.

The levator ani

The condition of this muscle is probably the most important factor in rectal prolapse and this was recognized by Ambroise Paré (1634), who drew attention to the prolapse which may follow "a palse of nerves which goe from the Holy-bone to the Muscles the lifters up of the Fundament". The exact anatomy at the ano-rectal region continues to excite the interest of proctologists but all work has stressed the close attachment of the ano-rectal canal to the pubo-rectalis fibres of the levator ani and the external sphincter muscle. This attachment, which is more marked posteriorly and laterally than it is in front, does not usually prolapse itself and thus explains the groove around the presenting rectal prolapse. It has been shown that in the erect position the levator raphe or "plate", that portion of the muscle upon which the rectum lies before reaching the levator hiatus, is almost horizontal. When straining takes place in the normal female, the vagina is forced backwards against the rectum and the rectum is forced backwards against the levator muscle. The muscle becomes more oblique but this tendency is restrained by its co-ordinated contraction and particularly by those fibres arising from the pubes. As long as the muscle is efficient, straining tends to compress the rectum antero-posteriorly rather than push it downwards. If the levator tone is poor, the picture in the erect position is now very different and in patients who suffer from complete rectal prolapse the line from the coccyx to the levator hiatus, instead of being almost horizontal in the erect position, is now almost vertical (Fig 70). The rectum now lies almost vertically over the levator hiatus and on straining it tends to be pushed down into the hiatus. The ano-rectal region is attached at its circumference to the levator but the anterior wall of the rectum at the bottom of the pouch of Douglas comes down first through the anus, followed by the remainder of the prolapse. As this is repeated the hiatus becomes still wider and the muscle still weaker. Some of these appearances can be demonstrated by myograms of the levator ani and by barium traces of the rectum (Muir, 1955).

The evidence suggests that weakness of the levator ani is the most important factor in the development of rectal prolapse and that this is more likely to occur if in a patient with a weak levator there is a particularly deep pouch of Douglas. The ideals in treatment would seem to be the strengthening or protection of the weak levator ani and an alteration of the anatomy in the pouch of Douglas. Operations designed to strengthen the levator have been performed from above, when the two halves of the levator have been sutured together between the rectum and the vagina,

or from below by a perineal exposure; if the anatomy of the muscle is carefully examined, however, it is hard to believe that such sutures can ever effectively contain the muscle in its new and abnormal situation. If the muscle cannot be directly strengthened, attempts can be made to protect it by preventing the prolapse. This, and alterations to the pelvic peritoneum, can only be performed by an abdominal operation. Recto-sigmoidectomy, the resection of the prolapse from the perineum, cannot achieve the desired object. In the past its use has been followed in many cases by recurrence and incontinence (Thompson, 1949), but because it has a very low mortality it still has a place in the treatment of complete rectal prolapse. It should, however, be reserved for patients unfit for an abdominal operation.

ABDOMINAL OPERATIONS FOR RECTAL PROLAPSE

Moschowitz's original operation, in which the pouch of Douglas was obliterated by sutures, did not prove a success and there have been many variations, in some of which attempts were made to suture the levator ani from above; in others where the rectum was stripped up and resutured in a different position. Lloyd-Davies (1949) advises the formation of a new rectovaginal septum by non-absorbable suture and the tethering of the rectum in position by the use of floss-silk slings attached to the sacro-spinous ligaments. Butler (1954) described the abdominal removal of the deep pouch of Douglas, perineal rectosigmoidectomy, suture of the colon to the side wall of the pelvis and ventrofixation of the uterus. For some years the author has used the operation of *anterior resection in the treatment of these cases* and believes it has certain advantages.

Anterior resection for complete rectal prolapse

The essential steps of the operation are the same as when it is used for malignant disease. The left iliac colon and sigmoid should be mobilized at the brim of the pelvis



FIG. 71.—The deep pouch of Douglas displayed at operation in the same patient. The cervix can be identified below the retractor.

so that the line of descent from the splenic flexure is almost straight. The fixity of the splenic flexure seldom varies and though the success of the operation does not depend on the security of the left phrenico-colic ligament, one of its objects is to excise sufficient of the rectum and sigmoid so that further prolapse is impossible. The peritoneal incision around the rectum in the pouch of Douglas should be wide; there will be no shortage of peritoneum here and the peritoneal floor and its deep prolongation down the posterior vaginal wall are to be excised (Fig. 72). The mobilization of the rectum must be quite complete and display the levator muscles on either side and the raphe posteriorly. Where there has been complete prolapse for some years



FIG. 72—Excision of the pouch of Douglas shown in Fig. 71

the lower rectum is large and capacious, if it is not fully mobilized it will not have the opportunity to form fresh adhesions and the amount of rectum remaining below the site of resection is more difficult to assess. After mobilization a suitable point is selected for the division of the rectum and a clamp applied. The rectal stump remaining after the division should extend on the straight some 3 to 4 inches above the levator ani, somewhat longer than would remain after an operation for carcinoma.

A Wertheim hysterectomy clamp is a convenient one when performing this operation for carcinoma but in prolapse the rectum is usually rather wide and a large right-angled clamp is preferable. The clamp is applied at or about the level of the peritoneal reflection on the front of the rectum, the anterior rectal wall divided below it, picked up by a stay suture, the lumen of the rectum swabbed out and the division of the rectum completed. Vessels lying in the perirectal fat on the posterior wall of the rectum will almost certainly bleed. They should be picked up with long artery forceps, such as Roberts, and ligated with catgut. A suitable spot on the sigmoid colon is now selected which will excise all redundant bowel but avoid tension. A clamp is applied obliquely and the bowel divided above it. No clamp is used on the piece of bowel to be anastomosed. If the lumen of the bowel appears unduly small it

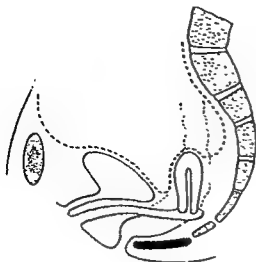


FIG. 73 —The position sought at the completion of the operation with the vagina and uterus fallen back on the right of the pelvis, the rectosigmoid anastomosis on the left and the peritoneal plane passing down over the front of the uterus and broad ligaments without a pouch of Douglas.

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may be slightly enlarged by a small incision along the antimesenteric border. Five or six interrupted mattress sutures of catgut are now inserted, but not tied, between the whole thickness of the posterior wall of the sigmoid, whose mesenteric border will lie on the right, and the whole thickness of the posterior wall of the rectal ampulla, where the needle should pick up the perirectal fat. The sutures are to apply the posterior walls in apposition and after they have all been inserted the sigmoid is slid down the sutures to the rectal stump and the sutures tied.

The anastomosis is now completed in the pelvis by a continuous catgut suture and outside this interrupted sutures of catgut or silk for the lateral and anterior parts of the anastomosis are inserted. When completed the anastomosis lies to the left of the mid-line, the sigmoid passing over the line of the left sacro-iliac joint to reach it. The deep peritoneal floor of the pouch of Douglas has been excised with the rectum. The peritoneum is now stripped up off the back of the broad ligaments and the side walls of the pelvis and resutured in such a way that at the completion the sigmoid will



FIG. 74 —Post-operative film in the knee-elbow position of a patient with complete rectal prolapse treated by anterior resection

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pass downwards in the left posterior quadrant and the uterus tubes and upper part of vagina will lie in the right posterior quadrant of the pelvis. The ideal is that no pouch of Douglas should remain and that the peritoneal plane of the posterior abdominal wall will pass into the pelvis over the front of the uterus (Fig 73). When the abdominal part of the operation has been completed a small incision is made near the coccyx and a corrugated rubber drain introduced so that it lies in the hollow of the sacrum, behind the anastomosis. It prevents the collection of blood and serum in the pre-sacral space and probably also increases adhesions in this region.

Post-operative care

Until normal peristalsis has returned and flatus has been passed, the patients are kept on intravenous fluids. The perineal drain is shortened and removed on the third and fourth days. It is convenient to have continuous bladder drainage for the early post-operative days. Since the anal sphincter in these patients is stretched and somewhat atonic there is no necessity for the use of a flatus tube. When the patient has become mobile she is instructed in sphincter exercises and given faradic stimulation. Once the constant stretching of the levator hiatus by the prolapse has been stopped the muscle has a chance to recover its tone and though many of these patients have some difficulty in controlling liquid faeces in the immediate post-operative period, it is remarkable how quickly the majority of them recover from this disability.

Advantages of the operation

The advantages that may be claimed for this operation are several; it performs a radical excision of the prolapse and since it does so from the abdomen it is possible to excise all redundant bowel. Adhesions form around the anastomosis, fixing it to



FIG. 75.—Barium enema three years after the operation of anterior resection for complete rectal prolapse. Note the straight line down from the splenic flexure.

PART I—ORIGINAL ARTICLES

the sacrum and soft tissues of the pelvis. With the sigmoid on the left and the uterus and adnexa on the right there is a block over the very part of the pelvis that was previously so weak. The levator ani is given a chance to recover. Skiagrams taken of the rectosigmoid region at varying periods after the operation suggest that a recurrence of the complete rectal prolapse would be anatomically impossible (Figs. 74 and 75). though some mucosal prolapse has occasionally occurred after the operation of anterior resection performed for carcinoma. Finally, though it is a major abdominal operation it is one that has a remarkably low mortality and elderly patients, particularly women, seem to stand it well.

Criticisms of the operation

The criticisms against this operation are that it is a major operation for which few patients are unsuitable and that it excises part of the rectum. Patients suffering from complete rectal prolapse are seldom fully continent; patients with a normal sphincter upon whom an anterior resection is performed for carcinoma may experience some temporary difficulty in the control of their bowels, particularly if the remaining rectal stump is small. If an anterior resection is performed upon a patient already incontinent, there is the risk that while curing the prolapse the incontinence may be worsened. For this reason it is essential to leave an adequate rectal stump. Of the 10 patients upon whom the author has now used this operation for complete rectal prolapse several have had temporary difficulty but with one exception all have regained good continence. The one exception is a patient who still suffers from some incontinence 3 months after the operation. This patient also had complete uterine prolapse. Her levator hiatus was greatly stretched and though her rectal prolapse has been effectively cured her anterior and posterior vaginal walls still prolapse on straining. Further operative measures will be required. No patient has yet shown any recurrence of the rectal prolapse.

It is said that some patients with complete rectal prolapse are old, stout and of low mentality. No doubt this is true but apart from age it has not been the author's personal experience. Most of the author's patients have been bright-eyed old ladies in their seventies and eighties, whose active life of shopping and housekeeping has been ruined for them by the humiliating discomfort of a complete rectal prolapse. "I am now able to lead a normal life, doing my housekeeping and looking after an invalid sister. It is such a happy change for me . . ." wrote a lady of 79 years of age who had had the operation 2 years before.

CONCLUSION

It is justifiable to urge that some form of operative treatment should be adopted for complete rectal prolapse in all but the frailest patients and that whenever possible the operation should be by the abdominal route. It is worth a risk to restore these patients to their activities and the risk is a small one.

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FIG 76—Sialogram of parotid showing parotid abscess as result of subacute infective parotitis. The arrows indicate the abscess

used to occur in the late stages of chronic mental illness, but is now rare. It is still seen from time to time in institutions nursing patients in the late stages of malignant disease. Under these circumstances, it is often referred to as *acute cachectic parotitis*, and, apart from severe infective features, necrosis of the gland may result so that it is sometimes an *acute gangrenous parotitis*. The prognosis of these types of parotitis is very bad and the complication is often a terminal one.

In the aforementioned conditions the infections are the primary cause of the parotitis, that is to say, the infection develops in previously healthy glands. If the patient recovers from the infection, whether with or without abscess formation, there is no special tendency for the condition to recur. Duct-borne infections may, however, occur as a secondary phenomenon in other varieties of parotitis, for example, secondary to calculus formation and in recurrent parotitis of obscure origin.

Tuberculous parotitis is rare, but not so rare that the possibility of its occurrence can be ignored. It seems to be commoner in France than in Great Britain, and Redon (1955) had 24 cases between 1940 and 1955. We have recently analysed the clinical and pathological features of 6 collected cases (Patey and Thackray, 1954).

Clinically, primary tuberculous disease of the parotid presents as a slowly growing lump in the parotid, which is usually diagnosed as a parotid tumour. The correct diagnosis is only made either if the lump caseates, which may be late, or on surgical exploration.

Pathologically, two types are found. In the commoner, the disease affects the intraparotid lymph nodes which as a normal anatomical feature contain parotid tubules; less commonly, there is diffuse replacement of parotid gland lobules by tuberculous granulation tissue (Fig. 77). The tuberculous affection of the parotid is not necessarily or even usually accompanied by tuberculosis of the lymphatic glands of the neck or tuberculosis elsewhere, and this, together with the fact that it is the facial process of the parotid which is most often affected, raises the possibility of a local origin such as a duct or periductal lymphatic spread from the mouth. A relation



FIG 77—Low power view of a parotid gland showing numerous foci of tuberculosis, some with central caseation, scattered throughout the lobules ($\times 52$)

between tuberculosis of the parotid and the uveal tract used to be postulated (uveo-parotid syndrome), but it is now thought that most cases of this syndrome are examples of sarcoidosis.

Tuberculosis of the parotid is often treated by parotidectomy under the wrong diagnosis of parotid tumour, but such treatment is of value in any case since there may be multiple foci of tuberculosis in the gland.

PAROTITIS SECONDARY TO CALCULUS FORMATION

In contra-distinction to the submaxillary gland, calculi in the parotid gland are rare. An apparent exception to this is the fact that on careful microscopical examination of parotid glands removed surgically for parotitis of obscure origin, one not infrequently finds small calculi about one millimetre in diameter in the intra-lobular ducts. They may also be seen on straight radiographs as small faint opaque spots. They are not usually associated with the obvious inflammatory areas, and we have therefore regarded them as incidental.

The parotid calculi of clinical importance are usually situated in the main duct or one of its larger branches. Their cause, as in the case of the commoner calculi in the submaxillary gland, is unknown. The typical clinical picture is one of recurrent parotitis, only to be distinguished from other types of recurrent parotitis by the demonstration of the calculus. There may be the syndrome of increased swelling of the gland after meals as in the submaxillary, but in the parotid this is a much less marked feature. Sometimes the calculus can be seen at the duct orifice, or be felt on probing the duct. If there is secondary infection, the duct orifice may be oedematous and congested, and there may be an associated purulent discharge. The patient will sometimes note the passage of the calculus into the mouth with an associated sudden



FIG 78—Phleboliths in haemangioma of parotid, simulating calculi.

FIG 79—Same case as Fig. 78 showing haemangioma after injection of diodone into vascular spaces



relief of symptoms. In spite of the fact that parotid calculi, like those of the sub-maxillary gland, are stated to be composed predominantly of calcium carbonate and phosphate, they may easily be missed on radiological examination, partly because the calculus is usually of small size, and partly because it may be obscured by the bony structures of the neighbourhood. For these reasons, Redon (1955) stresses that before a calculus of the parotid duct can be excluded, intra-oral films must be taken. We would also lay stress on the importance of tangential films designed to avoid the superposition of the calculus on the bone structures. We have had two cases in which the calculus was demonstrated as a negative shadow on sialography. The only condition which can reasonably be mistaken radiologically for a calculus is a calcified phlebolith in a haemangioma. A phlebolith is smooth, rounded, and sometimes laminated (Fig 78), and sialography shows that the shadow is outside the duct system. Redon has reported a similar case. In our case the diagnosis of haemangioma was completely established by Dr. J. N Pattinson by direct intravascular injection of diodone (Fig 79)

If the calculus passes spontaneously, no further treatment is necessary though further calculi may form. If the calculus does not pass spontaneously, it may do so following dilatation of the duct by lachrymal probes or following enlargement of the duct orifice. Rarely, particularly in diffuse intra-glandular calculi, parotidectomy with preservation of the facial nerve may be indicated.

RECURRENT OR CHRONIC PAROTITIS OF OBSCURE ORIGIN

In contra-distinction to acute non-specific infective parotitis and parotitis secondary to calculus formation, which show no special tendency to recur, cases of parotitis



FIG 80—Bilateral slowly progressive swelling of parotid glands of many years development as manifestation of chronic parotitis.

of obscure origin are not infrequently seen, the main feature of which is their persistence or recurrence.

There are two main clinical pictures; the commoner is that of recurrent painful swelling of one or both parotid glands. The condition may start either in childhood (Pearson, 1935; Jones, 1953) or in adult life. Women appear to be more commonly affected than men (Payne, 1933). Suddenly, without obvious reason, the parotid gland becomes diffusely and often markedly swollen, the swelling usually showing no variation in size with meals. There may be fever at first, but this does not usually last for more than a day or so. The swelling persists with diminishing pain, and in bad attacks may not completely subside for a week or two. If the condition manifests itself in both glands, it does not usually do so simultaneously, and is often more marked on one side. The initial attack having subsided, further attacks may not occur for months or years, but on the other hand they may occur so frequently that in the case of children the amount of time lost from school may become a problem.

Apart from the swollen gland, there are no other abnormal physical signs, and in between attacks there is nothing abnormal to be seen clinically.

The second and less common clinical picture is of gradual painless enlargement and induration of one or both parotid glands (Fig. 80). Usually the swelling involves the whole gland. Occasionally, it may be confined to a part of one gland, in which case the differentiation from a tumour of the gland may be difficult or impossible without surgical exploration. There may be a combination of these clinical pictures. Thus, there may be recurrent painful swelling of one gland, and a progressively enlarging painless swelling of the other, or the condition may start with recurrent swelling and later continue as a gradually enlarging, tumour-simulating swelling of the same gland.

In the earlier stages, there is no obvious bacterial infection, and the duct orifice is normal. After the condition has persisted for some time, particularly in the type



FIG. 81.—Sialogram of parotid to show main duct dilatation.

with recurrent swelling, infection with mouth organisms may become superimposed, and there is then the added picture of an acute or subacute infective parotitis with an inflamed oedematous duct orifice from which pus may be expressed. Under these circumstances, abscess formation may also occur.

Radiological appearances

Sialography after injection of Lipiodol into the duct may give valuable information in these cases of recurrent parotitis. It has recently been shown, however (Thackray, 1955; Patey and Thackray, 1955), that interstitial extravasation is easily produced in the parotid, particularly in this condition, so that the test should be used with caution. Small quantities should be injected, in the first instance starting with 0.5 millilitre or less, and even such a small amount may fill the duct system. It is unwise, too, to rely on the criterion frequently adopted of waiting for the patient to complain of



FIG. 82.—Sialogram of parotid of child aged 6 to show so-called "sialectasis". Only 0.3 millilitre of opaque medium was used in this case.

discomfort before stopping the injection since marked extravasation may occur before this stage is reached.

Two main types of radiological picture are obtained: (1) main duct dilatation (Fig. 81), and (2) glandular "sialectasis" (Fig. 82).

The differentiation between the two is usually easy. The dilatation of the main duct in the first type does not extend beyond the primary divisions of the principal duct, and the intra-lobular ducts are normal. If more dye is injected, the pattern of the glandular acini shows up as a diffuse cloudy opacity. Occasionally, there may be a combination of both types of radiological picture, that is, dilatation of the main ducts associated with glandular "sialectasis", but any marked degree of both in combination is uncommon.

The glandular "sialectatic" picture is well known under a multiplicity of names, for example, "globular sialectasis", "bronchiectatic type sialectasis", and the "image en grains de plomb" of the French. Until recently it was regarded, as the term

"sialectasis" implies, as resulting from dilatation of the small intra-glandular ducts. Recent work, however (Thackray, 1955; Patey and Thackray, 1955), in which the radiological and histological pictures of parotidectomy specimens from cases of chronic parotitis were carefully compared, has shown that such is only partially the case, and that the globular areas represent for the most part areas in which the dye has



FIG. 83 —Sialogram to show main duct dilatation associated with intra-glandular filling defect (indicated by arrows) due to lymphoid hyperplasia

extravasated interstitially through weakened duct walls. It is this finding which renders caution in the amount of the dye injected particularly necessary in these cases. The question will be further discussed under pathological anatomy. The extravasated dye may persist in the gland for weeks, months, or even years, particularly if large amounts are used, another reason for using the minimum amount that will give a diagnostic picture. The characteristic "sialectatic" picture may be present on both sides with symptoms confined to one side, or confined to the side of the symptoms.

Another occasional sialographic finding is a filling defect in the gland. This is much more common with the "sialectatic" picture but may also occur with main duct dilatation (Fig. 83). It occurs in the later stages of the disease, and is due to replacement of the gland lobules by lymphoid tissue. In the later stages, too, the number and complexity of the intra-glandular duct systems may be reduced, partly from the lymphoid hyperplasia and partly from blocking of the ducts through the epithelial

under pathological anatomy.

ings, it should be pointed out that the two

main clinical pictures of chronic parotitis already described—recurrent painful

SALIVARY GLANDS—PAROTITIS

swelling of the gland, and a progressively enlarging tumour-simulating condition may each be associated with either of the radiological pictures—main duct dilatation or glandular “sialectasis”, but if there is marked, persistent, and progressive enlargement of the gland, the “sialectatic” picture is much the more common.

Pathological anatomy

The pathological findings in glands removed for chronic or recurrent parotitis are considerably, but two main types of histological picture can be recognized. The first, which approximately corresponds to the radiological type with main duct dilatation, the dilated main duct can be seen surrounded by a dense fibrous tissue. The lobular pattern of the gland is still recognizable with the low power microscope, but there is an increase in the interlobular fibrous tissue. The intra-lobular ducts are also surrounded by hyaline fibrous tissue, but most of the smaller ducts have disappeared. There is marked atrophy of the acini with lymphocytic infiltration (Figs 84 and 85). This is a similar picture to that met with in obstruction of the main duct by a calculus.



FIG. 84.—The main duct of the parotid grossly dilated with dense fibrous tissue surrounding it and separating the lobules of the gland ($\times 21$).

Two types of histological picture are seen in association with the “sialectatic” type of parotitis, which appear to be stages in the development of the same lesion. In the early stages, there may be little or no naked eye abnormality. Microscopically the main duct and its interlobular branches are normal, apart from a little lymphocytic infiltration of the periductal supporting fibrous tissue. The typical changes are found in and around the large intralobular ducts. At first, there is marked periductal lymphocytic infiltration, with fragmentation and disappearance of the connective tissue fibres of the duct wall. As the attacks recur the zone of inflammatory infiltration becomes more marked, and germinal centres appear in the accumulated mass of lymphocytes. The lumen of the affected duct may show some dilatation from loss of its supporting fibrous tissue, but often there is proliferation of the ductal epithelial cells, which together with the pressure of the mass of lymphoid tissue become narrow and eventually block the lumen. Occasionally, when secondary infection supervenes, the ducts are full of pus cells. The acini corresponding to the affected

intralobular ducts show varying degrees of atrophy. At this stage, the lesion is a patchy one, affected and normal lobules occurring side by side (Fig. 86)

In the later stages, most of the lobules in the gland may be replaced by lymphoid tissue (Fig. 87), in which lie solid branching columns of epithelial cells representing all that remains of the duct system (Fig. 88). The picture thus shows comparable features to that of chronic lymphadenoid thyroiditis. Even in these advanced cases, the interlobular fibrous tissue with the associated main ducts may be relatively



FIG. 85.—Atrophy of the secreting acini of the parotid gland, and replacement by fibrous tissue infiltrated with lymphocytes. Fibrosis around the larger ducts and between the lobules. From the same case as Fig. 84 ($\times 21$)

unaffected. Occasionally, however, there may be some periductal and interlobular

latation. The naked-eye appearance of glands

Whereas the normal parotid is composed of brown colour with loose interlobular connective

tissue, in this condition the lobules are swollen and rounded, soft and white. Glands with this advanced condition of the lesion show focal or general swelling from the excess of lymphoid tissue present, and a mistaken diagnosis of tumour may be made either clinically or because a filling defect is present on radiological examination. Histologically, too, a mistaken diagnosis of tumour may be made, particularly if only small portions of tissue are available for examination, lympho-epithelioma being simulated.

Apart from the pathological changes due to the lesions themselves, other changes may result as a response to the sialographic examination. Serial section studies correlated with radiography of surgically removed glands (Thackray, 1955; Patey and Thackray, 1955) have shown that the "sialectatic" picture radiologically is due essentially to escape of globules of the oily contrast medium interstitially through ruptures of the degenerated intralobular duct walls. These escaped globules in the course of time are surrounded by histiocytes and foreign body giant cells (Fig. 89), and excite a marked fibrous reaction. Some of the radio-opaque medium is carried off to the intraparotid lymph nodes, where it can be recognized in the peripheral sinuses (Fig. 90). The existence of this artificially produced chronic parotitis emphasizes



FIG. 86—Chronic "sialectatic" parotitis, showing some comparatively normal lobules and others with considerable amounts of lymphoid tissue around the intralobular ducts. Areas of extravasation of oily contrast medium marked X. Main duct at centre relatively unaffected ($\times 21$).

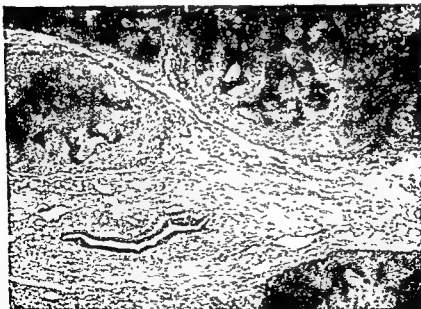


FIG. 87—Advanced case of chronic parotitis showing lobules of the parotid gland enlarged and almost replaced by an accumulation of lymphoid tissue in which solid columns of epithelial cells are recognizable. Interlobular connective tissue relatively unchanged ($\times 21$).



FIG 88 —High power view of part of Fig 87 to show the islands of epithelial cells in the background of lymphoid tissue ($\times 75$).

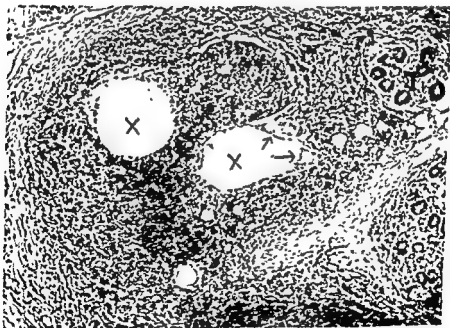


FIG 89 —Two areas of extravasation (indicated by Xs) in a chronically inflamed parotid gland following previous sialography. The globules are surrounded by histiocytes and foreign body giant cells, two of which are indicated by arrows ($\times 110$).

the importance of care in performing the diagnostic test of sialography and in particular of using the minimal amount of injection medium.



FIG. 90—Oily globules with foreign body giant cells (indicated by arrows). The globules are in the peripheral sinus of an intraparotid lymph node. From a case of chronic "sialectatic" parotitis in which sialography had been performed ($\times 110$).

Differential diagnosis

In the early stages, as already noted, a diagnosis of mumps is frequently made, particularly in children. In cases with a history of recurrent swelling, the diagnosis is easy and is confirmed by the sialographs. In cases in which the condition presents as a gradually enlarging swelling of the parotid, particularly if unilateral and localized, the differential diagnosis from tumour may be difficult or impossible clinically. Even the demonstration of a characteristic radiological picture does not exclude tumour, as a combination of tumour and chronic parotitis may co-exist. Apart from tumour, diffuse parotitis may be simulated by parotid hypertrophy, and by hypertrophy of the masseter muscle. In the former, the "parotidomegalie essentielle" of Redon, both parotid glands, though large to the point of cosmetic disability, may be quite normal both to sialography and even on biopsy. Idiopathic hypertrophy of the masseter (Fig. 91), which may be unilateral or bilateral, should not in theory be mistaken for a parotid swelling but sometimes is, even to the point of surgical exploration.

Aetiology

As already indicated in our classification, the cause of the conditions which have been discussed is obscure and as a rule largely a matter of speculation, but, as has been seen, two fairly clearly defined types can be recognized, one of which has as its characteristic feature dilatation of the main ducts with periductal fibrosis and lobular fibrosis and atrophy, the other of which shows no marked dilatation of the main ducts nor periductal fibrosis, but the most striking feature of which is lymphocytic accumulation around and fragmentation of the intralobular ducts. Though in the later stages the microscopical findings tend to approximate, it would appear most



FIG 91—Case of hypertrophy of left masseter muscle simulating chronic parotitis

likely that in the beginning we are dealing with two separate conditions with aetiological factors. With regard to the main duct dilatations, the radiological and clinical appearances described here are those met with when the parotid gland is removed for a definite obstructive lesion such as a calculus. Thus, the cases which Figs. 84 and 85 were taken had a history of the passage of calculus into the duct previously, and clinical evidence of fibrous obstruction of the duct orifice. In other cases with similar radiological and pathological findings without a calculus, it is reasonable, therefore, to postulate some latent obstructive cause. Many suggestions have been made—oedema or fibrosis of the duct papilla from trauma or infection from the teeth (Rose, 1954), a plug of mucus secreted by the mucous glands of the main duct (Payne, 1933), or a fibrinous plug from allergy. Gross dilatation of the main parotid ducts may be demonstrated in control post-mortem subjects with a history of salivary gland disorder, thus raising the possibility of an achalasia of the duct orifice. Under these circumstances, the onset of symptoms might be due to infection in the relatively stagnant contents of the dilated duct. In favor of an obstructive aetiology is the occasional clearing up of the condition following dilatation or enlargement of the duct orifice. Tentatively, therefore, even when

If the aetiology is often not clear in the above group, it is still less clear in the "sialectatic" group, and the problem has to be posed and studied afresh in light of the knowledge that the essential lesion is not a true sialectasis of the gland comparable to bronchiectasis, but primarily a weakening of the intralobular duct walls associated with lymphocytic infiltration. Thus, the theory that the condition is congenital (Bailey, 1945) in the sense that an individual is born with a honeycomb-like gland, is no longer a correct posing of the problem. There may be a congenital factor, but if so it must be something more subtle such as some pre-disposition to the lesion. Such a pre-disposition might depend on local or general factors.

Of local factors, the most striking is the limitation of the "sialectatic" picture to the parotid glands, the condition not having been described in the submaxillary glands, and in confirmation of this, while the radiological picture of "sialectasis"—though with differences from that seen clinically—is easy to produce in post-mortem subjects in the parotid, it cannot be produced in the submaxillary (Ranger, 1956). In other words, the "sialectatic" picture is an incidental artefact, but one peculiar to the parotid, and more easily produced in certain types of chronic parotitis than in the normal gland.

In further search of possible local factors, one of us (A.C.T.) has been studying the detailed structure of normal and pathological parotid glands by serial microscopical sections. Contrary to what is usually taught, some parotid glands in addition to the well recognized mucous cells at the duct orifice do contain numerous mucous and even sebaceous glands (Fig. 92), sometimes in large numbers. The presence of sebaceous material in the secretion of the gland might have abnormal mechanical influences, and an endeavour is being made to see whether there is any correlation between the presence of such glands and the development of the "sialectatic" lesion. The study, which is obviously a laborious one, is as yet not sufficiently complete for conclusions.

The other more obvious local factors that have often been suggested as causative in the "sialectatic" type of parotitis are infection and obstruction, but infection is



FIG. 92.—A sebaceous gland liberating its cells into an intralobular duct in the parotid. This was one of many hundreds present in the gland removed from a recent case of recurrent parotitis ($\times 275$)

clinically late, and the cases of undoubted primary infective parotitis such as after operation show different radiological and pathological features, and also no special tendency to persist or recur. It seems more likely, therefore, that infection in these cases of chronic parotitis is a secondary phenomenon. The existence of the lesion radiologically before any symptoms is also a point against a primary infective cause. Against a primary obstructive cause is our ignorance of such a cause, and the fact that the pathological picture in undoubted obstructive conditions is quite different. If there is obstruction it is due to something not so far demonstrated, and at the intralobular duct level.

Suggestions have been made that alterations in the constitution of the saliva may be a responsible factor, and as evidence is adduced the fact that the secretion coming from an affected parotid duct may appear more viscid than normal. Investigations carried out on a small number of our cases (Kirk and Pawan) have, however, failed to demonstrate any consistent change in either the viscosity or the protein content of the saliva from the affected glands. The occasional increased viscosity of the initial salivary secretion, which we too have noted is, therefore, presumably due to inflammation of the terminal parotid duct with its well recognized contained mucous cells. Such a condition might cause obstruction and dilatation of the main ducts, but could not reasonably explain the "sialectatic" picture.

Of general factors which might be responsible, allergy has frequently been suggested (Meyer, 1934; Munro, 1951; Smith, 1953). There has, however, been little attempt to work out the nature of the postulated allergic reaction nor its mode of action. Occasionally a typical parotitis may be present with associated trouble in the other salivary glands, the lachrymal glands, or elsewhere.

It will be convenient to mention in conclusion two eponymous conditions—Mikulicz disease and Gougerot-Sjögren's disease. Mikulicz (1892), under the title of *A peculiar symmetrical disease of the lachrymal and salivary glands*, reported the case of an East German peasant aged 42 years with a history of swelling of lachrymal, parotid, sublingual and submaxillary glands of both sides for 7 months. He removed the lachrymal and submaxillary glands, which microscopically showed replacement of the epithelial elements by masses of small round cells with occasional mitoses. Three months later, the patient died in his own village of a reputed "perityphlitis"; there was no post-mortem examination. No material for histological examination was ever taken from the parotid glands, and there is in fact no proof that the swelling of these glands was due to involvement of the salivary tissue rather than of the intraparotid lymph nodes. Mikulicz discussed at considerable length the possible inflammatory process which he finally termed "Mikulicz disease" of obscure origin of a dumping ground in which it is impossible

to define accurately, has probably had a sterilizing influence on salivary gland pathology, and there is an increasingly widespread feeling that it should now be abandoned.

The Gougerot-Sjögren concept is more recent. In 1925, Gougerot, a French ophthalmologist, described a condition of a progressive atrophy and dryness of the eyes, nose, and sometimes also of the glands of other regions such as the nose, larynx, and vulva. The condition did not excite much interest until 1932 when Sjögren, a Swedish ophthalmologist, described with full pathological and clinical details a similar general syndrome in which, in addition to the dryness of the eyes, rheumatic symptoms in joints, dryness of the mouth with a tendency to swelling of the parotids, and a diminution of perspiration were prominent features. The condition is therefore generally referred to as Sjögren's

disease, though in France it is known as Gougerot-Sjögren's disease. The histological picture in some cases of the syndrome (Sjögren, 1933; Morgan and Raven, 1952) does appear to resemble that found in our cases of "sialectatic" parotitis with the marked lymphocytic and lymph follicular accumulations, but in other cases (Ellman, Parkes Weber and Goodier, 1951) the picture appears to be one of simple atrophy with fibrous and fatty replacement. While, therefore, the concept of Gougerot-Sjögren's disease is valuable in drawing attention to the importance of general factors in recurrent parotitis, it is probable that the syndrome covers a number of different conditions, and care should be exercised that it is not allowed to degenerate into the diagnostic dumping ground for obscure parotid conditions that Mikulicz disease has become.

Treatment

The treatment of these obscure forms of parotitis must from the very fact of their obscurity be difficult and often unsatisfactory. It may be considered under the following (1) expectant; (2) minor duct orifice surgery, (3) irradiation; and (4) parotidectomy.

Expectant

Many cases of chronic or recurrent parotitis may give rise to so little in the way of symptoms, or at such long intervals, that the best course is to do nothing active except to relieve symptoms as they occur. In such cases, it is particularly important not to make the condition worse by excessive injection of the contrast medium when sialography is carried out, which as already mentioned may produce "chronic sialographic parotitis" from the physical and chemical trauma.

Minor duct orifice surgery

In the cases with main duct dilatation, it may be worth trying, particularly if there is evidence of stenosis, dilatation of the duct orifice by the passage of lachrymal probes, or enlargement of the orifice by slitting it up, with suture of the duct wall to the cheek mucosa. But in cases without changes in the main duct, as in most cases of glandular "sialectasis", such procedures can obviously be of no benefit and may even be harmful by inducing stenosis or predisposing to infection. It should be noted that the operation of enlargement of the duct orifice, while in theory simple, is in practice often technically unsatisfactory and not infrequently followed by stenosis.

Irradiation

This may occasionally be helpful particularly in cases of glandular "sialectasis" associated with pseudo-tumour formation. High doses are usually necessary and the resulting dryness of the mouth may be temporarily very uncomfortable (Gerry and Seigman, 1955). Irradiation is undesirable when marked secondary infection is present, and also in young children owing to the danger of interfering with the growth of the jaws.

Conservative parotidectomy

The development and standardization of the modern operation of parotidectomy with preservation of the facial nerve provides a technical answer to the case which is unsuitable for or fails to respond to other measures. It should obviously not be lightly advised because of the potential danger to the facial nerve. When carried out with patience and care serious permanent danger to the nerve is rare and the results are most gratifying. In practice, the operation tends to be reserved for cases in which the possibility of tumour cannot be excluded, for children in whom the frequency and severity of the attacks are interfering with schooling, and for adults in whom the attacks are seriously interfering with their work.

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Period of suppression of function

During the period of suppression of function from injury of either cord or roots it is impossible to discover the extent of anatomical damage, and so long as this condition persists in complete form there must be uncertainty as to the possibility of any recovery of function.

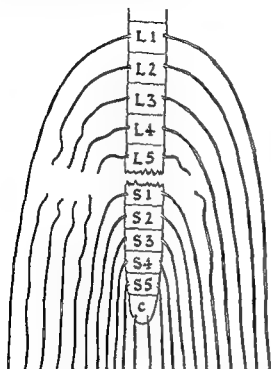


FIG. 93.—Diagram illustrating a mixed cord and root lesion. Clinical examination of this patient would reveal paralysis and anaesthesia from the second lumbar segment on one side and from the fifth lumbar segment on the other. These clinical findings might erroneously be interpreted as a partial cord lesion at the second lumbar segment.

It is for this reason that there is so much controversy about the initial treatment of the injury. If the cord is anatomically divided no form of treatment can alter the prognosis. If the cord and roots are anatomically intact, recovery will occur without treatment, and all that is necessary is to protect them from further damage. If, however, there is a partial lesion then the need to protect the intact fibres from further damage is essential. In a root lesion, even if there is anatomical division of the axons, recovery is theoretically possible. Thus, in planning rational treatment, any guide to the true nature of the cord and root lesion must be of great importance.

DIAGNOSIS

The first essential in the diagnosis of the nerve lesion is to distinguish the paralysis and anaesthesia due to the cord lesion from that due to lesions of the nerve roots, for the latter may recover even if divided so that the prognosis of root injury is always better than that of cord injury. Moreover, unless the distinction is made, a mixed complete cord and root lesion, especially if an unequal number of roots is divided on each side, is frequently mistaken for a partial cord lesion at a higher neurological level, leading to a totally erroneous prognosis (Fig. 93).

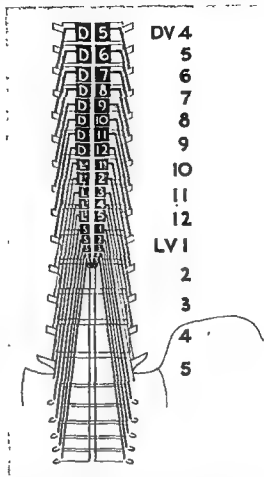
Distinction between cord and root lesion

Accurate distinction between cord and root lesion depends upon a knowledge of the anatomical relationship between the spinal cord and the vertebral column (Fig. 94) and upon the fact that the nervous lesion can, with very few exceptions, be shown to be at the level of the vertebral injury (Holdsworth, 1954).

From Fig. 94 it will be seen that the cord ends at the lower border of the first lumbar vertebra. Below this level the spinal canal contains the nerves of the cauda equina, and injuries below the first lumbar vertebra will therefore result in root lesions only.

Above the ninth dorsal vertebra the cord segments are roughly opposite the corresponding vertebra and injuries above this level can therefore be considered as pure

FIG. 94.—Diagram illustrating the re-
vertebrae



cord lesions. Between the ninth dorsal and the first lumbar vertebrae, however, lie all the lumbar and sacral neurological segments, and all the lumbar nerve roots. Injury at this level, for example between the twelfth dorsal and first lumbar vertebrae will divide the cord at the first sacral segment, and all the lumbar nerve roots, thus producing a clinical paraplegia as high as the first lumbar segment of which only the sacral paralysis and anaesthesia is due to cord injury, the rest is due to damage to the roots. Various patterns of root and cord injury can occur as illustrated in Fig. 95, each producing a different neurological pattern *with the same cord lesion*.

The injury illustrated in Fig. 93 is especially liable to be erroneously interpreted on clinical examination as a partial cord injury at the L2 neurological segment. Thus, careful neurological and radiological examinations should be made to determine the level of the cord lesion. If this is carried out it will be impossible to confuse root escape with partial cord injury, for only the presence of sensation or motor power, or both, in the segments below the cord level can indicate a partial lesion.

Total temporary suppression of function (spinal shock)

The temporary complete suppression of function below the level of a cord injury makes diagnosis of the exact nature of the cord lesion difficult. The difficulties,

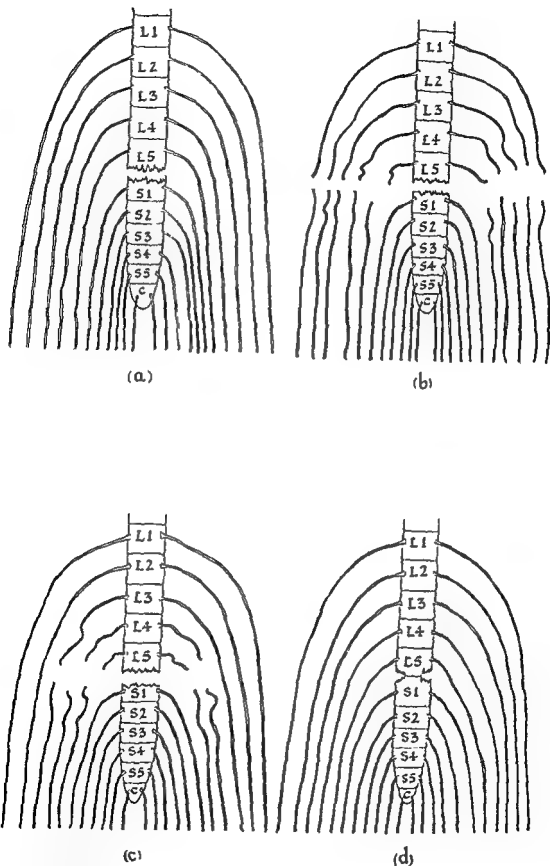


FIG. 95.—Patterns of root and cord injury: (a) Complete cord division with complete root escape; (b) complete cord and root division; (c) complete cord division with partial root escape; (d) partial cord division with complete root escape

below the cord injury, an accurate diagnosis can be made within 8 hours.

Stability of the spine

In the dorsal and lumbar regions stability of the spine after fracture or dislocation depends upon the damage sustained by the posterior ligamentous complex, articular facets and not upon the damage to the vertebral body. If the

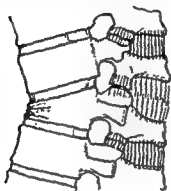


FIG. 96.—Stable crush fracture of the vertebral body. The posterior ligaments are intact.

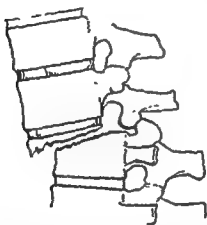


FIG. 97.—Rotational fracture-dislocation of the spine. The "slice" fracture of the lower vertebra and the lateral displacement of the spinous process and articular processes are characteristic.

ligaments remain intact then the vertebral body is crushed and the fracture is impacted and stable (Fig. 96). Further displacement will not occur unless the spine is subjected to violence in excess of that which originally produced the fracture. Such fractures are only rarely associated with paraplegia. The distortion of the vertebral canal is not great and therefore reduction of the deformity followed by splinting is unnecessary.

Fracture-dislocation of the spine associated with rupture of the posterior ligamentous complex and fracture of one or both articular processes is usually the result of severe torsional violence. A rotational fracture-dislocation results which is extremely unstable. This is the type of fracture-dislocation commonly associated with paraplegia (Fig. 97). It can be recognized by clinical examination and by the typical radiological appearance. On palpation of the back a gap can be felt between the spinous process of the injured vertebrae due to rupture of the supraspinal and intraspinal ligaments. The radiographs show a lateral shift of the articular processes and spinous processes and

SPINAL COLUMN—TRAUMATIC PARAPLEGIA



(a)



(b)

FIG 98 —Skagrams of a typical (a) and (b) rotational fracture-dislocation. The "slice" fracture and lateral displacement of the spinous and articular processes are well illustrated.

extreme instability of this injury original displacement is reduced films are exposed with the patient in this position, or in the lateral position with the shoulders and the pelvis held in line, the displacement shown may be very slight. With this type of fracture-dislocation the slightest torsional strain on the spine will reproduce severe displacement. Such fracture-dislocations must be supported during the time necessary for repair to occur.

In the *horizontal* position

Ru

the *lateral* *mass* *displaced* *facets*. In such injuries the intervertebral disc is often protruded causing additional damage to the cord (Fig. 99). Dislocations of this type are best reduced by skull traction, using the Blackburn type of skull caliper. After reduction the spine remains unstable and re-dislocation may occur. It is therefore advisable that the spine should be held by internal fixation either by a bone graft or by wiring the spinous processes together.

Extension violence, especially in the elderly, may cause rupture of the anterior longitudinal ligament with hyperextension of the upper vertebra upon the lower. Such injuries cause cord damage by compression by the unfolding of the ligamentum flavum (Fig. 100). Such dislocations are stable, however, provided the head is held in flexion by means of a collar.

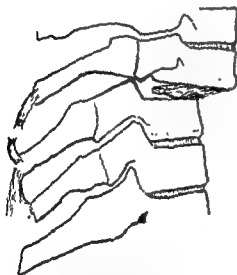


FIG. 99.—Dislocation of the cervical spine. The posterior ligaments are ruptured.



FIG. 100.—Extension injury to the cervical spine. The anterior common ligament is ruptured and the spine angled backwards.

TREATMENT

Careful neurological and radiological examinations will enable the following facts to be elicited 6-8 hours after injury: (1) the amount of cord and root damage; and (2) whether or not the cord is anatomically divided.

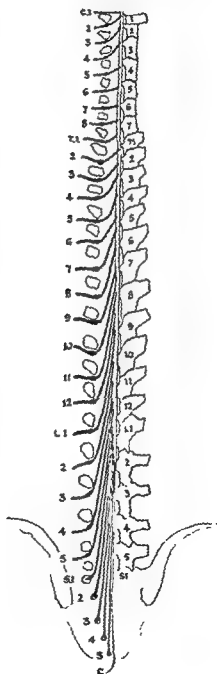
Palpation of the back and radiological examination will also reveal whether the bone injury is stable or unstable. With these facts in mind immediate treatment can be decided upon a rational basis.

Anatomical division of the cord*Cervical and upper dorsal regions*

In the cervical region and in the region above the ninth dorsal vertebra the root injury is unimportant for the neurological segments are almost opposite the corresponding vertebrae (Fig. 101). Thus, if the cord is divided recovery cannot be expected and the object of treatment of the vertebral injury is simply to prevent deformity.

At these high levels deformity is not very important, for it is unlikely that caliper walking will ever be of real use to the patient. Thus, in the dorsal region careful

FIG 101.—Diagram of the vertebral column, the cord and the roots to show the relationship of the cord segments to the vertebrae.



nursing is all that is necessary, but in the cervical region the special difficulties of nursing may make it advisable that the spine should be fixed by internal fixation.

Dorso-lumbar region

It is in the dorso-lumbar region that mixed cord and root lesions occur and since, as previously stated, the cord is more vulnerable to injury than the roots, escape of roots in the presence of complete cord division is not infrequent. Even if the roots appear divided on early examination, they may recover function weeks after the injury.

In fracture-dislocation of the dorso-lumbar junction all the lumbar roots may be involved. These roots control hip flexion and knee extension and the sensation of almost the whole leg (Fig. 102); their escape or recovery is therefore of the greatest functional importance. A patient with a lumbo-dorsal fracture-dislocation, transection of the cord at the S.1 segment and complete root escape will be able to walk with short calipers, whereas a similar cord injury with complete root division will have flail legs necessitating full-length calipers and crutch swinging (Fig. 103).

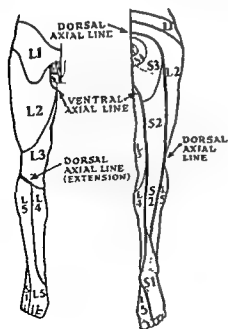
Thus, in lumbo-dorsal injuries resulting from unstable fracture-dislocation, the roots must be protected and the spine splinted so as not to impede their possible recovery. With stable fractures, of course, such splinting is unnecessary.

Lumbar region

The cord ends at the lower border of the first lumbar vertebra; therefore injuries below this level result in pure root lesions. Recovery is always possible in such lesions, and as with unstable fracture-dislocations the spine must be supported.

Partial cord lesions

With partial lesions of the cord, the result of unstable fracture-dislocations at any level, the spine must be stabilized to prevent further cord damage. If the partial cord lesion is the result of a stable fracture then, clearly, support to the spine is unnecessary.



SEGMENT and ROOT	MOVEMENTS HIP • KNEE • ANKLE	REFLEXES
L1		CREMASTERIC
2	FLEXION & ADDUCTION	
3	EXTENSION	KNEE
4	EXTENSION & ABDUCTION	DORSI-FLEXION
5	FLEX	PLANTAR RESPONSE
S1	PLANTAR FLEXION	ANKLE
2		GLANS BULBAR
3		
4		ANAL
5		

FIG 102.—Segmental sensory innervation of the leg, together with a diagram indicating the functions of the lumbar roots

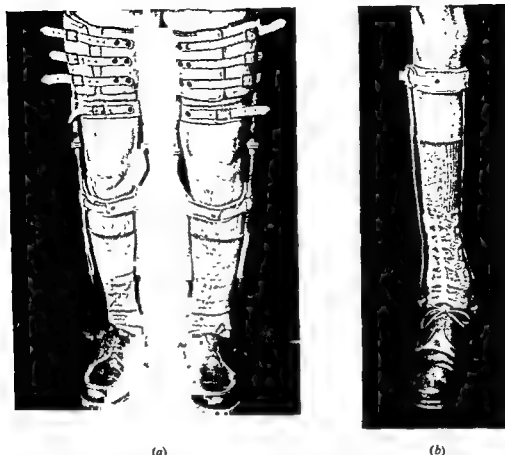


FIG 103—Two patients with cord division at the S1 segment. One patient (a) also has complete lumbar root division and requires long calipers, the other (b) has complete lumbar root escape and requires only short calipers, as his hips and knees are stable

Methods of stabilization of the spine

Fractures and fracture-dislocations associated with cord and nerve-root damage can be divided into stable and unstable types. If the vertebral injury is unstable then some form of splinting is desirable during treatment to prevent movement occurring at the site of injury. Prevention of movement at the fracture site is important for two reasons. First, because movement might cause further damage to a partial cord or root lesion and might obstruct recovery in damaged roots. Secondly, to prevent permanent deformity of the vertebral column, for marked angulation of the spine adds to the difficulties of rehabilitation.

After unstable fracture-dislocation the vertebral column may be held firm during the period of healing, either by external splinting or by internal fixation. Two methods of external splinting are available: (1) plaster applied as a jacket or a plaster bed with turning case; and (2) a Styker frame.

Plaster jackets and plaster beds

The results of nursing paraplegic patients in plaster beds are disastrous (Fig 104). The anaesthetic skin is peculiarly vulnerable to pressure, and large sores can be produced in a matter of hours unless the pressure areas are changed with great frequency. This is impossible with plaster beds or jackets and large sores usually result. In a series of 16 patients nursed in plaster beds every patient developed one or

more intractable bedsores (Holdsworth and Hardy, 1953) The method is mentioned only to be thoroughly condemned.



FIG 104—Plaster sores, the result of nursing in a plaster bed.

(By courtesy of the Editor of *J Bone Jt Surg*)

Styker frame

The Styker frame is a mechanical rotating bed on which the position of the patient can be changed frequently so as to prevent sores. The method is sound but requires expert attention and is expensive. It is, however, comparatively safe, for turning can be carried out with the shoulders and pelvis held in alignment. Complete immobility of the fragments is, however, difficult to obtain, and, of course, in fracture-dislocations reduction of the deformity must be carried out first.

Operative reduction and internal fixation

Open reduction and fixation of the spine by metal plates bolted to the spinous processes has many advantages (Fig 105). Such internal fixation, if properly performed, results in excellent stability and the patient can be nursed in an ordinary bed and regularly turned to prevent bedsores with no fear that further displacement of the vertebrae will result in damage to the contents of the spinal canal. In fracture-dislocations with gross displacement the method follows upon reduction, which is the method of re-alignment least likely to cause further injury to the cord and roots.

Technique

A midline incision is made sufficiently large to expose at least four spinous processes. The interspinous ligaments are cut, and the laminae are removed with a high-speed burr or spinal chisel or wide periosteal elevator the mass of the erector spinae muscles is cleared from the spine and laminae laterally to expose the lateral articulations. The dislocation is then clearly visible and the extent of damage to the articular processes easily seen. The spinous process of the vertebra above and that below are seized with powerful bone-



FIG 105—Skiagrams of a fracture-dislocation of the spine fixed by plates bolted to the spinous processes (a) and (b)

At least four—better five—spinous processes are then drilled with an angled awl; three above and two below the dislocation. Fixation of at least four vertebrae is necessary for the dislocation is a rotational displacement and plating of only two or three vertebrae will still allow lateral rock of the upper upon the lower vertebra (Fig. 106). The holes should be drilled in the centre of the spinous processes.

If properly applied to the spinous processes the affected part of the spine will be held rigid for 12–15 weeks, and by this time anterior fusion of the affected bodies is sufficiently advanced to hold the dislocation. The loosening of the plates which may occur after this time is therefore unimportant.

Except in the cervical region fixation should be by plates and not by bone grafts; the latter frequently break under the torsional strains which may result from turning. Moreover, since, as already stated, artificial fixation is for only 12–15 weeks, a graft is therefore unnecessary.

advocated by Williams are most suitable. The muscles and skin are then sutured back into place.

If properly applied to the spinous processes the affected part of the spine will be held rigid for 12–15 weeks, and by this time anterior fusion of the affected bodies is sufficiently advanced to hold the dislocation. The loosening of the plates which may occur after this time is therefore unimportant.

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Complications

Although the operation is usually simple, difficulties can arise. Interlocking of the articular processes may result in difficulty in reduction. The locking can be overcome by increasing the deformity with the spinous processes held firmly in bone-holding

forceps and by angling the spine forwards. It is important not to remove intact articular processes for this adds to the instability after reduction and increases the strain on the plates.

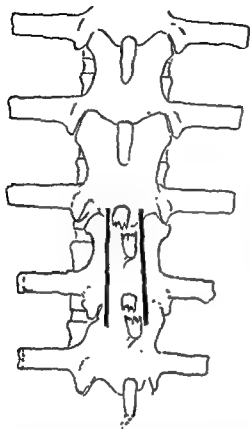


FIG. 106 —If only two spinous processes are fixed by the plates the fracture cannot be controlled Rock can occur, the spinous processes will give way, and the plates will rapidly work loose.

One or more spinous process may be fractured. If one or two are fractured the difficulty can be overcome by extending the plates to the two sound spinous processes above and below. If, however, more than two are fractured it is probably better to abandon internal fixation and to rely on the Styker frame, or upon expert nursing with the greatest care in turning.

It should be unnecessary to state that the operation must be performed properly and with care. It is useless to use one short plate fixing only two vertebrae, to plate the wrong vertebrae or to use screws instead of bolts. Under these circumstances failure is inevitable, and serious harm may result. Bad technique combined with complete lack of understanding of the principles of and indications for the operation are no criticism of the method.

Nursing

In the past most paraplegic patients died within 12–18 months. Death was most frequently due to chronic suppuration in huge bedsores together with urinary infection leading to renal failure.

Bedsores are the result of continuous pressure on the anaesthetic skin, and such pressure for only 6–8 hours will result in a large bed sore, the full extent of which may not become evident for 2–3 weeks. Thus, in the paraplegic patient, unless the skin areas taking pressure are frequently changed sores will inevitably result. For this reason plaster or any other form of splint must never be used.

The method of nursing on pillows with regular turning every two hours, day and night, as advocated by Guttman is the most certain way of preserving an intact skin. The patient is supported on pillows (Fig 107) so that the trochanters, the sacrum, the ankles and the heels are free from pressure. Every two hours he is turned from the left side to the back, from the back to the right side and so on, day and night. After



FIG 107—Nursing position. Splints or plaster are not used at any time

6-8 weeks the skin acquires some tolerance to pressure, and moreover, the patient learns to turn himself with assistance, but throughout his life he is always liable to sores, the result of continuous pressure upon the skin. Careful instruction in avoiding pressure forms an important part of the rehabilitation of the patient. So successful is this method of prevention that bedsores are no longer a problem in the Paraplegic Unit.

The bladder

The treatment of the paralysis of the urinary bladder which follows injury to the cord and roots is of vital importance. The comfort, the well-being and even the life of the patient depend upon the proper initial treatment and correct re-education of the bladder.

Efficient bladder drainage must be instituted within 24 hours of the injury. There is considerable difference of opinion as to the best method of drainage. Four methods are available.

Manual compression

The bladder is allowed to fill for 3-4 hours and is then partially evacuated by manual compression of the lower abdomen. The advantage of this method is said to be that by refraining from catheterization urinary infection can be avoided; most authors are agreed, however, that the persistent high residual urine which results from this method often results in urinary infection. Moreover, manual compression is difficult to apply and requires very skilful and conscientious personnel. The general conclusion appears to be that whilst the method may have advantages in selected cases, drainage methods are in general much more efficient.

Intermittent catheter drainage

Almost all authors are agreed that intermittent catheter drainage is the worst method. Repeated catheterization invariably leads to urinary infection, and should not be used for the paralysed bladder.

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THORAX-CONGENITAL DEFORMITIES.

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FUNNEL CHEST (PECTUS EXCAVATUM)

Aetiology

This deformity is congenital in origin. The theory that rickets is the cause is untenable on all the evidence. Biochemical studies, radiology, and clinical examination of the patients offer no support to rickets being a causative factor. Add to this that most of these children are well nourished, coming from good homes.

All workers in this field agree that the deformity is due to the diaphragm exerting an abnormal pull on the xiphoid and the sixth costal cartilage, thereby dragging the sternum in on inspiration (Brown; 1939, 1951; Ravitch, 1951; Brodtkin, 1953; Lester, 1954; Hirtz, 1954; and Hausmann, 1955). The following observations support the diaphragmatic theory.

In babies the deformity is labile and is produced only on vigorous inspiratory efforts, such as laughing and crying. In these infants, when deep inspiration is taking place the whole sternum is dragged back, producing a severe degree of funnel chest deformity. On relaxation of the diaphragm, that is, during expiration, the chest flattens out again and appears normal. The degree of the deformity depends directly on the degree of inspiration.

Experiments have been carried out by paralysing one phrenic nerve, and it has been observed in infants that this has produced an asymmetrical deformity on inspiration. Experiments have also been carried out with bilateral paralysis of the phrenic nerve, and in such cases the deformity on inspiration is almost completely abolished.

On screening these patients in the lateral position, backward retraction of the sternum occurs synchronously with the descent of the diaphragm.

Mechanics of production

That the diaphragm is the active agent which produces the deformity is accepted, but the precise anatomical defect in this fibro-muscular sheet, and the abnormal forces resulting from this defect, are still open to conjecture.

Brown (1939) stated that it was due to a short central tendon, but this cannot be so, as the deformity at no stage would be labile and capable of complete obliteration.

Paradoxical movement

Brodtkin (1953) felt it was due to a poorly developed muscle in that part of the diaphragm which arises from the septum transversum, that is, the component of the diaphragm coming from the xiphoid and sixth costal cartilage. Because of its poor quality this portion is unable to act with the force that is required on the central tendon, and thus is pulled down and in with the central tendon on inspiration by the more powerful surrounding muscle. The result is that the lower end of the sternum is dragged back on inspiration (that is, paradoxical movement).

Normal diaphragmatic movement

Normal diaphragmatic movement.

Types of deformity

There are four types of deformity.

Labile deformity

This is seen in babies. The deformity is present only on inspiration and is at its maximum when deep inspiratory efforts are made. In repose the chest looks normal.

Established deformities

There are three types in this group.

Type I.—The sternum is sharply angulated, usually at the level of the third or fourth costal cartilage. The angulation of the costal cartilages occurs well medially



FIG. 109—A typical Type I deformity. It is localized. The angulation is steep and close to the sternal margin. There is no flare of the costal margin.



FIG. 110—A typical Type II deformity. It is diffuse. The angulation occurs farther out. There is a marked flare of the costal margin.

and is acute. This results in the sort of depression you can "put your fist in". While kyphosis and abdominal protuberance may or may not be associated with this, "rolling out" or "flare" of the costal margin is not present. The acute angulation of the costal cartilage begins at the fourth costal cartilage and continues through to the seventh. Much less often the third costal cartilage also is acutely angulated (Fig. 109).

Type II.—This deformity is more diffuse. The sternum is not as steeply angulated as in Type I. Hence the angulation of the costal cartilages is less severe and it takes place farther away from the sternum. It is not as localized as Type I and it resembles an inverted plateau. Protuberance of the abdomen and kyphosis may be present, but a flare of the costal margin is always present. This deformity is more diffuse than Type I, and the third, and often the second, costal cartilages are involved (Fig. 110).

Type III.—The basic feature of this type is asymmetry. It may resemble Type I on one side and Type II on the contralateral side, and there is a rotation of the sternum, usually to the left. There is no doubt that this tilt of the sternum is the basic feature which causes the asymmetry of the costal cartilages.

It is usual in all types for the xiphoid to be impalpable, and paradoxical movement on inspiration depends on the degree of fixation of the deformity.

Symptomatology

It has been denied that these patients can have symptoms (Evans, 1946). It is true that many cases, and some with an extreme degree of deformity, deny any disability. Many of these cases, however, suffer a severe disability, particularly adults. It is only natural that such cases are commonly seen where curative surgery is performed. Many authors have recorded cases in which the patient has been disabled by this condition (Sauerbruch, 1931; Alexander, 1931; Ochsner and de Bakey, 1938; Carr, 1932, 1933; Master, 1949; Dörner, 1950; Ravitch, 1951; Lester, 1954; Chin and Adler, 1954; and Hausmann, 1955).

It is not surprising that symptoms should occur, as there is impairment of pulmonary function and a marked rotation of the heart to the left.

The patients seen in clinics can be put into four groups. Group (1) seek advice only for cosmetic reasons, and deny symptoms. The majority of patients in this group are children. Group (2) have a history of frequent colds and bronchitis. These symptoms often date from their first winter, and come with such a degree of frequency as to cause concern to the parents and to the doctor. Such cases are very common. It is not surprising that this should happen. Owing to the deformity these patients have an ineffective cough and they are prone to sputum retention with infection at both lung bases. Group (3) again complain of repeated bronchitis and dyspnoea, and inability to keep up with people of their own age in activities such as walking, running and swimming. They complain that they are always behind and are distressed in comparison with their fellows. Group (4) complain of dyspnoea which is progressive and has become disabling. Walking up stairs or up hills causes dyspnoea. On exertion, as well as dyspnoea, they suffer from palpitations, pain in the chest, and syncope. The history of repeated chest infection is very common. In this very severe group, patients have been seen complaining of dysphagia as well.

The common factor in all groups is that of repeated chest infections, and dyspnoea of varying grades.

Clinical examination

The clinical examination is the diagnosis. There should be no confusion between this deformity and any other of the many chest deformities which occur, such as congenital sternal prominence, manubrio-sternal prominence (pigeon chest), congenital lateral sulci, and deficiencies of the chest wall.

The degree of backward displacement of the sternum should be noted, and whether there is retraction of the sternum on inspiration (paradoxical movement), or whether the sternum is now fixed and has attained the maximum degree of displacement that is possible.

This paradoxical movement of the sternum is an important feature, particularly in young children, for a severe degree of paradox of the sternum is so often associated with repeated episodes of lung infection.

Kyphosis should be observed, and whether it is fixed or mobile. It is rare for it to be fixed in children. Other features are the presence of protuberant abdomen and a flaring of the costal margin. The latter is never found in Type I, but is common in Type II.

The clinical examination is carried out to assess (a) the type of deformity, and (b) the degree of the deformity

...satisfactory cosmetic result can be obtained in Type I. The most cases. In Type II, cosmetic results to eradicate the deformity completely, and at the best it can only be 80 per cent corrected. These patients are still left with the inverted plateau type of deformity, but it is less severe. However, it should be done for cosmetic and prophylactic reasons, as it prevents further progression of the



FIG. 111.—The result obtained after repair of the Type II deformity. The deformity has been improved and the posture improved, but there is still present an obvious degree of sternal depression.

deformity and allows the patient to attain a much better posture (Fig. 111). Type III is variable, but it is not usual to get a complete obliteration of the deformity, as in Type I.

Anaesthesia

Anaesthesia for this operation presents little difficulty. Surgery is facilitated when spontaneous respiratory movements are abolished and pulmonary inflation is produced by controlled artificial respiration. Such artificial respiration, under positive pressure, also minimizes the disturbances of the open pneumothorax produced if the pleural cavity is inadvertently opened during resection of the costal cartilages or during mobilization of the sternum.

Rectal thiopentone is favoured as a basal narcotic in small children. Induction in older children and adults is by the intravenous injection of thiopentone and a curarizing agent. Maintenance of anaesthesia is by endotracheal nitrous oxide and oxygen, often supplemented by intravenous pethidine and further curarization when necessary.

Endotracheal intubation

Endotracheal intubation is not normally required. Cardiac disturbance during operation has not been encountered.

Operative technique

Modified operation

This operation should be performed only when there is no degree of fixity. It is done, in other words, on a completely labile deformity, and for that reason it is only performed on babies in the first year or two of life. The modified operation will not correct an established deformity.

The object is to remove the attachment of the diaphragm from the chest wall at the point where it is pulled in and thus stop the inevitable progression of the deformity.

By a small transverse incision at the level of the sterno-xiphoid junction, the xiphoid is detached from the sternum and the upper half of the xiphoid is excised. A short length of the sixth and seventh costal cartilage is removed, leaving the posterior layer of the perichondrium. The attachment of the perichondrium to the sternum is divided and a small segment of the adjacent perichondrium is removed. The reason for excising part of the xiphoid and the perichondrium is to prevent re-attachment which will occur readily in babies.

Full operation

This operation is employed in the great majority of cases. It should be used in all cases where there is any degree of deformity at rest.

In adults the incision should always be a midline, longitudinal incision, extending from the level of the third costal cartilage to below the xiphoid. In children a transverse incision at the level of the fourth costal cartilage, running out to the nipple-line on either side, can be used. The only advantage that the transverse incision has over the longitudinal is that it is easier to get farther out on the sixth and seventh costal cartilages. The incision used is purely a matter of personal preference for the surgeon, and the operation can be done equally well through either.

The skin and subcutaneous tissues are undercut, and the edges are retracted. Any tissue that overlies the sternum is cleared away. The origin of the pectoral muscles on either side is then seen. The pectoral muscles are cleared off the costal cartilages on both sides. This is best done by sharp dissection with fine scissors of the Boyd's type, clearing up along the costal cartilages first, and then cutting the intervening muscle between the cartilages. Bleeding will be encountered in each interspace, the vessels being the perforating branches of the internal mammary arteries. These are easily controlled by diathermy. The reflection of the muscle should be carried out until the site of angulation of the cartilage is reached. The sixth and seventh costal cartilages are overlaid by the rectus abdominis. They can be displayed by carefully defining the upper and lateral border of this muscle and retracting it out of the way. Alternatively an incision can be made straight through the muscle. However, it is preferable not to cut through the muscle but to retract it after having mobilized its upper portion.

The sternum and costal cartilages are now displayed and all the deformed costal cartilages must be removed to just beyond the site of angulation. Any costal cartilage which is angulated to any degree must be removed, and this usually means the third to the seventh. It is important to leave the posterior layer of the perichondrium. This is best achieved by running the diathermy point along the upper and lower borders of the cartilage; then by a blunt rugine clearing a small portion of the upper and lower borders. A Mayo's towel clip then takes a firm bite into this area and by strong traction the cartilage is bowed up. The cartilage is then cut into with a knife at the most convex point, and if firm traction is maintained, as the knife approaches the

posterior layer of the perichondrium, the cartilage will divide, leaving this perichondrial layer intact. The perichondrium can then be stripped off the cartilage in both directions, by either a dissecting swab or a blunt rugine. The intercostal muscles are cut off the upper and lower borders by scissors. If this routine is followed the dissection of the perichondrium from the cartilage is a simple matter. This manoeuvre is repeated on both sides from the third to the seventh costal cartilages.

The xiphoid is then gripped with a towel clip and elevated firmly. With a small-bladed knife a nick is made in the perichondrium of the seventh costal cartilage, and sharp scissors are placed through this behind the xiphoid. The xiphoid is then cut from the sternum by cutting down on to the scissors with a knife. The upper portion of the xiphoid is then resected.

The lower end of the sternum is now gripped with a towel clip and forcibly elevated. With a finger the back of the sternum is swept clean of all surrounding tissue, taking

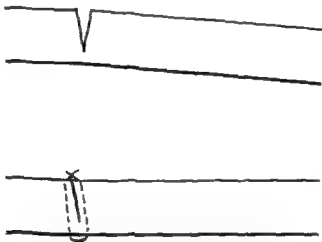


FIG. 112.—The extent of the wedge osteotomy, which is extended through practically to the posterior table, when the sternum is lifted forward this posterior table is fractured.

care to reflect the pleura at either side. This clearance of the retro-sternal space should be carried up to the level of the second costal cartilage. After this is done, the pleura must be inspected for any tears. Having done this, the perichondrium of the sixth and seventh costal cartilages is detached from the sternum, and the sternum is again elevated to see if any of the other layers of perichondrium is holding it down. Any layer which obstructs the elevation of the sternum should be detached from it. It may sometimes be necessary to detach the fifth and the fourth, but rarely.

A transverse osteotomy must now be performed at the site of angulation of the sternum. The periosteum is reflected back from the elected site by a transverse incision through it. A transverse wedge osteotomy is then performed in the sternum down to the posterior table, but not through it. This can easily be done by a sharp chisel. The sternum is then lifted well forward, fracturing the posterior table at the site of the osteotomy.

The tip of the sternum is again elevated well up by traction on a Mayo's towel clip, and two drill holes are made above and below the site of the osteotomy, the mediastinum being protected by a copper strip along the posterior aspect of the sternum. When this has been completed a double ligature of 25 thread is carried through the drill holes on a needle, and these are tied firmly with the sternum held in the over-corrected position (Fig. 112). The periosteum is then apposed by two or three interrupted sutures of 40 thread.

The extent of the resection is shown in Fig. 113. It is usual to resect about $\frac{1}{4}$ inch of the perichondrium of the sixth and seventh cartilage to avoid re-attachment.

The pectoral muscles are now sewn to each other across the mediastinum by interrupted sutures. The space is then carefully examined for any bleeding points, the most likely being the anterior intercostals or branches coming from the internal mammary on either side. The pleura is again inspected to make sure there is no tear. If a small tear is present, it can be repaired, the anaesthetist fully inflating the lung when the final closure is made. If the tear is extensive or the pleura too fragile to hold sutures, it can be left open. The space is then drained by a small stab wound below the main

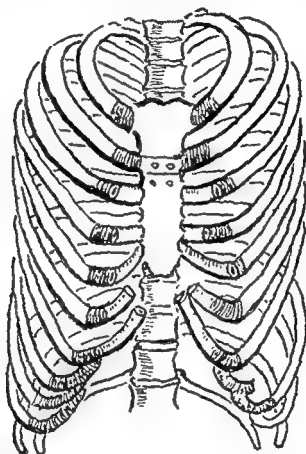


FIG. 113—It is seen that the costal cartilages have been removed sub-perichondrially from the third to the seventh. A portion of the perichondrial layer of the sixth and seventh has been removed. A wedge osteotomy has been performed above

incision. Drainage is best performed by a small tube and this tube must be connected to underwater drainage. Drainage is important as there is always a sero-sanguinous effusion, and if left it can place strain on the suture line. While careful inspection may have been carried out, it is possible unwittingly to have made a nick in the pleura, and if the drainage is open, then the patient will have a total pneumothorax. Hence drainage should always be of underwater type.

The skin is now closed by interrupted sutures. No supports are used such as rib struts or wire. These are unnecessary and can be painful.

Post-operative care

There is nothing special that need be done. It is important of course that these patients should cough adequately, and that after the removal of the tube, which is usually on the second or third day, a careful watch be kept on the wound for fluctuation. If there is any fluctuation, then the fluid should be aspirated. The patients are got up on the second or third day, and immediately their posture is taken in hand by the physiotherapists. This is a most important aspect of post-operative care, and very important in children. Their bad postural habits are long established and therefore are difficult to break and it is always advisable to train the parents in postural treatment as well as the patients, so that this can be carried out at home.

Post-operative complications

Paradoxical respiration

Paradoxical respiration is always present for 2 or 3 days, but never to a degree enough to worry the patient. If severe troublesome paradox occurs, it is the result of a pneumothorax. This can happen if the drainage tube is not connected to an underwater seal. Once the pneumothorax is obliterated by aspiration, severe paradox will cease.

Wound rupture

This will occur on removal of the suture if adequate aspiration has not been carried out.

In the main, post-operative complications are extremely few. In a series of fifty cases, these are the only two that have occurred.

Results

Results can be divided under three headings.

Symptomatic

The symptomatic improvement in all cases is uniformly good. When the patient has such symptoms as frequent chest infection, dyspnoea, pain in the chest, palpitations, and syncope, these can be cured. In a large series, there have been severely disabled patients who have led a semi-invalid life, but have now returned to full activities. Even in the asymptomatic group there is a persistent story of improvement.

Cosmetic

In Type I the cosmetic improvement is excellent. Most have 100 per cent correction of the deformity, and at worst it is 90 per cent.

In Type II it is more disappointing. An 80 per cent correction of the deformity may be obtained, but sometimes less.

In Type III the results are variable and unpredictable, but at least a 70 per cent correction should be obtained and sometimes 100 per cent.

Recurrence

Recurrence of the deformity is unusual, but it does occur, and there are two factors which are responsible.

Inadequate surgery—Failure to drill the manubrium at the site of the osteotomy, and relying on periosteal sutures only.

Failure to detach any band of perichondrium which is anchoring the sternum, and failure to excise the upper half of the xiphoid and part of the sixth and seventh perichondrium, thus allowing re-attachment.

Bad postural habit—The other factor responsible for recurrence is the continuation of bad postural habits, particularly in children.

PART I—ORIGINAL ARTICLES

DEFICIENCIES OF THE CHEST WALL

Definition

These deficiencies are not common, but are seen mostly in the upper, anterior part of the chest wall. There may be an absence of the costal cartilages with or without associated absence of part of the sternum.

Aetiology

There is no doubt that they are congenital in origin and there may be associated abnormalities, such as a deformity of the hand on that side, asymmetry of the upper limbs, and absence of the pectoral muscles, either entirely or in part.

Clinical signs

The deficiencies are apparent on clinical examination. There may be paradoxical movement of the chest wall at the site of the deficiency, and this paradox will always increase if pulmonary infection occurs. Abnormal cardiac pulsation may be present. Such examples are deficiencies on the left side over the pulmonary artery or over the myocardium itself. Marked pulsation is apparent in the area, and this is what is troublesome to the patient.



FIG. 114.—Deficiency of part of the sternum and the costal cartilage, with absence of the sternal portion of the pectoralis major. Marked cardiac pulsation was present under the sternal and costal cartilage deficiency.

Indication for repair

Where marked cardiac pulsations or pulmonary artery pulsations are present, it is advisable to carry out repair. The patient has a fear of damage to his heart and is often seen wearing a large leather cuirass, having been instructed to indulge in no vigorous activities. Naturally this is irksome to a boy (Fig. 114)

Technique of repair

It is often possible to lay in bone grafts across the site of the deficiency. Split bone graft is the most effective method, and the bone is readily obtained by sub-periosteal resection of one of the boy's own ribs. It is necessary to freshen the donor sites by reflecting the periosteum and scarifying the bone. The graft should be fixed by drill holes and transfixion sutures.

Results

Operation results in giving support to the area, obliterating the abnormal pulsations, and giving the patient confidence, so that he can indulge in full activities.

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URETER-TRANSPLANTATION INTO THE ILEUM

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PRINCIPLES OF URINARY DIVERSION

Diversion of the urinary stream from its normal course through the bladder is carried out following cystectomy for carcinoma of the bladder or as a palliative procedure in that condition to relieve pain and frequency; for the contracted bladder which may follow healed tuberculosis; for interstitial cystitis or recurrent attacks of long-standing chronic cystitis; for the treatment of ectopia vesicae; for the relief of incurable vesico-vaginal or vesico-recto-vaginal fistula following injuries at child-birth or after radiotherapy for carcinoma of the cervix; and as a part of the operation of pelvic exenteration for extensive pelvic cancer.

Urinary diversion may be carried out by a number of different methods depending partly on the views of the surgeon, and partly upon the anatomical conditions present in the patient; the most suitable method for any given pathological state is often still controversial. The methods which are available are cutaneous ureterostomy, transplantation of the ureters into the colon and transplantation of the ureters into an artificial bladder made from a segment of intestine; such a "bladder" may be either a conduit for urine or it may be a reservoir. The ileal bladder is one of the varieties of artificial bladder.

Bilateral cutaneous ureterostomy

Bilateral cutaneous ureterostomy is practised by a small minority of surgeons. One disadvantage is that when the ureter has been mobilized in order to bring it out through the abdominal wall, a failure of the blood supply of the end of the ureter has sometimes led to terminal necrosis or stricture, the ureter retracting to the bottom of a small septic cavity from which secondary urinary fistulae may develop. A further disadvantage is that it is difficult to fit an apparatus to the abdominal wall which will collect the urine from the two ureterostomy openings without inconvenient leakage.

Uretero-colic anastomosis

The orthodox operation for urinary diversion when the rectum and colon are intact and the sphincter mechanisms of the anal canal are normal is uretero-colic anastomosis. The techniques most commonly practised are those of Stiles (1911), in which the ureter is secured to the wall of the sigmoid after having been passed into its lumen through a small opening; and of Coffey (1911), in which the ureter is made to pass into the lumen of the intestine through a tunnel in the submucous layer of the sigmoid and its end is then secured to the wall of the intestine. These two methods are followed not infrequently by the development of varying degrees of stricture at the anastomosis, leading to slight or medium-grade hydronephrosis which may perpetuate a renal infection. The methods of Nesbit (1948) and of Cordonnier (1949) which consist of a direct mucosa-to-mucosa union between the upper end of the divided ureter, cut obliquely so as to provide an elliptical opening, and the mucosa of the colon, generally avoid stricture formation at the anastomosis, but because of

the absence of a valve there may be reflux of colonic content to the kidneys with consequent pyelonephritis. The method of Leadbetter (1951) combines the principle of direct mucosa-to-mucosa union between the end of the ureter and the mucosa of the colon, with a valve to prevent reflux. None of these methods gives satisfactory long-term results in every case.

When the rectum has been removed and a colostomy has been made, urinary diversion can still be carried out if the bladder has also been removed by transplanting the ureters into the colon above the colostomy opening, but this procedure results in the highly inconvenient wet colostomy. Alternatively, the ureters can be transplanted into some form of artificial bladder made from a loop of bowel.

Artificial bladder

When the rectum is still present but its sphincter mechanisms have been damaged by injury or disease or are congenitally inadequate as in some cases of spina bifida, uretero-colic anastomosis is not appropriate, and if urinary diversion is then necessary the surgeon may elect to perform either bilateral cutaneous ureterostomy or he may divert the urine into an artificial bladder of which there are several varieties.

Artificial bladder made from the rectum and sigmoid colon

This procedure was first used in dogs by Mauclair (1895) and in human beings by Remedi (1906) and Kronig (1907); these workers divided the upper end of the rectum and implanted the two ureters into its invaginated upper end, bringing the proximal end of the divided intestine to the surface as an end-colostomy. The writer, using a similar technique, has used the rectum and the whole of the sigmoid colon as an artificial bladder in eight cases. Since the cavity of the "bladder" is free from faeces, and appears to develop only a very low bacterial content, and also because the amount of electrolyte absorption is small on account of the relatively short length of intestine which is used, these cases have been clinically very well. They have shown no evidence of ascending renal infection during a post-operative period of three years or more. Some degree of electrolyte imbalance has been noticed in some cases but it has been readily corrected by the usual methods. A colostomy is the price which has been paid for a good clinical end-result.

Artificial bladder constructed from the isolated ileo-caecal region of the intestine

This procedure was first carried out by Verhoogen (1908) and by Makkas (1910) and has recently been strongly advocated by Merricks and his colleagues (1951). A loop of terminal ileum, together with the caecum and ascending colon, is isolated and intestinal continuity is restored by an ileo-colic anastomosis. The ureters are transplanted into the caecum and the terminal ileum is brought to the surface as an artificial urethra through which the patient catheterizes himself at intervals. Once again the ureters drain into a faeces-free cavity. Electrolyte imbalance has been reported (Moore, 1953). The need for frequent catheterization is a disadvantage of this method.

Ileal bladder

The use of an isolated coil of ileum as an artificial bladder with a spout ileostomy was described by Kirschner (1939), and more recently it has been re-introduced by Bricker (1950). Cases have been reported by Annis, Hunter and Wells (1954) and by Pyrah and Raper (1955). Details of the operation will be given later.

PHYSIOLOGICAL AND PATHOLOGICAL CONSEQUENCES OF URINARY DIVERSION INTO THE INTESTINE

When any of the operations for urinary diversion are carried out, the kidneys are deprived of the delicate valve mechanism at the uretero-vesical junction, which

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This procedure was first carried out by Verhoogen (1908) and by Makkas (1910) and has recently been strongly advocated by Merricks and his colleagues (1951). A loop of terminal ileum, together with the caecum and ascending colon, is isolated and intestinal continuity is restored by an ileo-colic anastomosis. The ureters are transplanted into the caecum and the terminal ileum is brought to the surface as an artificial urethra through which the patient catheterizes himself at intervals. Once again the ureters drain into a faeces-free cavity. Electrolyte imbalance has been reported (Moore, 1953). The need for frequent catheterization is a disadvantage of this method.

Ileal bladder

The use of an isolated coil of ileum as an artificial bladder with a spout ileostomy was described by Kirschner (1939), and more recently it has been re-introduced by Bricker (1950). Cases have been reported by Annis, Hunter and Wells (1954) and by Pyrah and Raper (1955). Details of the operation will be given later.

PHYSIOLOGICAL AND PATHOLOGICAL CONSEQUENCES OF URINARY DIVERSION INTO THE INTESTINE

When any of the operations for urinary diversion are carried out, the kidneys are deprived of the delicate valve mechanism at the uretero-vesical junction, which

URETER-TRANSPLANTATION INTO THE ILEUM

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PRINCIPLES OF URINARY DIVERSION

Diversion of the urinary stream from its normal course through the bladder is carried out following cystectomy for carcinoma of the bladder or as a palliative procedure in that condition to relieve pain and frequency; for the contracted bladder which may follow healed tuberculosis; for interstitial cystitis or recurrent attacks of long-standing chronic cystitis; for the treatment of ectopia vesicae; for the relief of incurable vesico-vaginal or vesico-recto-vaginal fistula following injuries at child-birth or after radiotherapy for carcinoma of the cervix; and as a part of the operation of pelvic exenteration for extensive pelvic cancer.

Urinary diversion may be carried out by a number of different methods depending partly on the views of the surgeon, and partly upon the anatomical conditions present in the patient; the most suitable method for any given pathological state is often still controversial. The methods which are available are cutaneous ureterostomy, transplantation of the ureters into the colon and transplantation of the ureters into an artificial bladder made from a segment of intestine; such a "bladder" may be either a conduit for urine or it may be a reservoir. The ileal bladder is one of the varieties of artificial bladder.

Bilateral cutaneous ureterostomy

Bilateral cutaneous ureterostomy is practised by a small minority of surgeons. One disadvantage is that when the ureter has been mobilized in order to bring it out through the abdominal wall, a failure of the blood supply of the end of the ureter has sometimes led to terminal necrosis or stricture, the ureter retracting to the bottom of a small septic cavity from which secondary urinary fistulae may develop. A further disadvantage is that it is difficult to fit an apparatus to the abdominal wall which will collect the urine from the two ureterostomy openings without inconvenient leakage.

Uretero-colic anastomosis

The orthodox operation for urinary diversion when the rectum and colon are intact and the sphincter mechanisms of the anal canal are normal is uretero-colic anastomosis. The techniques most commonly practised are those of Stiles (1911), in which the ureter is secured to the wall of the sigmoid after having been passed into its lumen through a small opening; and of Coffey (1911), in which the ureter is made to pass into the lumen of the intestine through a tunnel in the submucous layer of the sigmoid and its end is then secured to the wall of the intestine. These two methods are followed not infrequently by the development of varying degrees of stricture at the anastomosis, leading to slight or medium-grade hydronephrosis which may perpetuate a renal infection. The methods of Nesbit (1948) and of Cordonnier (1949) which consist of a direct mucosa-to-mucosa union between the upper end of the divided ureter, cut obliquely so as to provide an elliptical opening, and the mucosa of the colon, generally avoid stricture formation at the anastomosis, but because of

Changes consequent on the incorporation of the ileum into the urinary tract

When the ileum is incorporated into the urinary tract as in the operation of ileocystoplasty, or when a long loop of ileum is used to replace a portion of the ureter excised because of injury or disease (Pyrah and Raper, 1955), or in the artificial closed ileal bladder joined to the urethra after cystectomy (Pyrah, 1956), the urine is in contact with a loop of ileum of varying but limited length, almost continuously, except when the bladder is completely empty, in these cases the ileum acts as a *reservoir* for urine. When a loop of ileum is used as a *conduit* for urine, as in the simplest form of ileal bladder (with a terminal ileostomy), urine is also in contact with the ileal mucosa, but only in small amounts since external drainage is quite free. Although the use of the ileum for such purposes has only come into use in the last four or five years and the total number of cases operated on is still comparatively small, no clinical syndrome similar to that following uretero-colic anastomosis has so far been reported and the incidence of hyperchloraemic acidosis has been low and in some series absent.

Bricker (1952) reported hyperchloraemic acidosis in one patient with an ileal bladder, who developed bilateral hydronephrosis of severe degree which later required operative revision; this associated pathology may have partly accounted for the imbalance. Wilson (1953) reported a temporary hyperchloraemic acidosis, which disappeared in two or three weeks, in a case of pelvic exenteration and ileal bladder performed for pelvic cancer. Annis, Hunter and Wells (1954) reported 21 patients with ileocutaneous ureterostomies, the majority of whom showed blood levels of the CO_2 -combining power either at, or slightly below, normal while the serum chloride levels were normal except in 4 cases in which there was hyperchloraemia. The serum potassium levels varied widely, 6 cases showing values slightly below normal, while several showed high normal and 3 had top normal or higher values. These findings were laboratory figures and no cases showing clinical evidence of hyperchloraemic acidosis were recorded.

Bricker, Butcher and McAfee (1954) reported 5 cases (2 fatal) of convulsive states which they thought might have had as cause some unrecognized fluid or electrolyte disturbance. These workers have not, however, found any complication proved to arise from the absorption of urinary constituents; they found hyperchloraemia in only 2 cases in their series of 65 patients, and in these, ileal bladder substitution had been performed for severe hyperchloraemic acidosis complicating previous uretero-sigmoidostomy. In 23 cases reported by the writer in which the ileum had been incorporated into the urinary tract for a variety of purposes (Pyrah, 1956), and which included 6 cases of ileal bladder, no case of hyperchloraemic acidosis was noted, nor were any symptoms observed which could be attributed to electrolyte imbalance.

In order to study experimentally the migration of sodium, chloride and potassium ions across the mucosa of the ileum, perfusion experiments using radioactive isotopes were carried out in a case of ileocystoplasty, and also in a woman suffering from uraemia due to congenital cystic kidneys for whom a two-foot loop of ileum had been used as an artificial kidney (Pyrah and his colleagues, 1955). It was found that sodium and chloride ions migrate across the mucosa of such a bladder into the blood stream and also in the reverse direction from blood to perfusing fluid. There was a small net uptake of sodium and chloride ions in approximately equal amounts into the blood stream. Potassium ions were also shown to move simultaneously in both directions across the ileal wall; it was shown that when the potassium concentration of the perfusing fluid was approximately three times that of the blood plasma (or approximately half the concentration of an average urine) there was a net absorption of potassium from the loop; it seems likely, therefore, that some absorption of potassium will take place when a loop of ileum is anastomosed to the

is the principal guard against ascending renal infection, a complication which may, in consequence, follow any of these procedures. When urine is diverted from its natural channels to any part of the intestine certain physiological changes occur in the composition of the urine which can sometimes be harmful. It is desirable to consider these changes in order to justify the use of the ileum as a urinary conduit or reservoir and also to understand the reasons which have led some surgeons to advocate the use of the ileal bladder to the exclusion of uretero-colic anastomosis as a means of urinary diversion.

Changes consequent upon uretero-colic anastomosis

When surgeons began to perform the operation of uretero-colic anastomosis with increasing frequency it was found that some patients, though making a good recovery from the operation, did not ultimately achieve normal health; a few patients gradually failed and died in coma.

Ferris and Odel (1950) first accurately described the clinical syndrome of electrolyte imbalance which was responsible for the observed sequence of events. Symptoms may start soon after operation, especially if there is an attack of pyelonephritis; or their onset may be delayed for months or years. The early symptoms, which may persist for a long time, are thirst, a distaste for food and loss of energy; coincident with these symptoms the face becomes shrunk and pallid, the tongue coated, the skin dry, and there may be evidence of anaemia. More important symptoms are the onset of nausea with occasional vomiting; an acute collateral illness such as acute bronchitis may precipitate urgent symptoms. There is then a complete distaste for food, with consequent wasting and loss of skin turgor; there is a raised pulse-rate and Kussmaul's breathing. Continued nausea and vomiting may be followed by increasing weakness, drowsiness and coma which may prove fatal in a few days unless vigorous corrective treatment is instituted.

Ferris and Odel (1950) found that a high proportion of patients who had undergone uretero-colic anastomosis had a hyperchloraemia and also an acidosis, as shown by a reduced CO_2 -combining power; the blood urea was also frequently elevated. These findings were soon confirmed by other workers and a large series collected by Jacobs and Stirling (1952) showed similar results. The mechanism of this electrolyte imbalance has been studied by Ferris and Odel (1950), Lapides (1951), Parsons and his colleagues (1952a and b), and by Annis and Alexander (1952). These researches, which have been summarized elsewhere (Pyrah, 1954), appear to show that the electrolyte imbalance results from two principal causes: (1) a differential absorption of chloride and sodium ions from the colon, chloride ions being absorbed in excess of sodium ions, resulting in a hyperchloraemic acidosis; these changes depend upon the physiological properties of the intact colonic mucosa; and (2) ascending infection from the colonic content to the kidneys, resulting in impairment of renal function, and especially of tubular function, so that the kidneys cease to play their normal part in securing homeostasis following the absorption of the electrolytes.

It is relevant to this discussion to state that the hyperchloraemic acidosis can be corrected by prohibiting the use of salt at the table, though allowing it in the cooking of food, by the daily administration of 4 grammes of bicarbonate of soda, and by encouraging the patient to micturate at frequent intervals by day and at least once during the night, in order to prevent the accumulation of a large amount of urine in the colon.

Careful follow-up and frequent biochemical examinations of the blood are a necessary routine in all cases. Any incipient renal infection must be treated. Since 1951, when this mode of supervision and treatment became a routine practice, we have had no cases of severe illness or coma consequent upon electrolyte disturbance secondary to uretero-colic anastomosis, and the general well-being and physical fitness of the patients have been greatly improved.

Changes consequent on the incorporation of the ileum into the urinary tract

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bladder. If renal function is normal, homeostasis of the potassium could be achieved, but if renal function is impaired there is real danger of hyperkalaemia. In this regard it is interesting to note that Tasker (1953) reported a patient upon whom an ileocystoplasty had been performed for a contracted bladder and who died on the twelfth post-operative day with a flaccid paralysis which may have been due to potassium intoxication; he also showed that in dogs in which an ileocystoplasty had been performed, the venous blood draining from the ileal graft when the bladder was filled with urine contained a significantly higher potassium content than when the bladder contained no urine.

INDICATIONS FOR THE CONSTRUCTION OF AN ILEAL BLADDER

Spina bifida

In cases of spina bifida with urinary incontinence and flaccid anal sphincter it is inappropriate to perform a uretero-colic anastomosis, and in such cases an ileal bladder gives very good results; since there is only one external urinary opening it is to be preferred to bilateral cutaneous ureterostomy. Some of these cases do not survive childhood because of infection in the urinary tract and because of hydrocephalus; those who survive may develop a moderate control of rectal function in early adolescence. It is therefore reasonable to wait until the child is between the ages of 12 and 15 years before constructing an ileal bladder. Since there is great variation in these patients, each case must be judged on its merits. It is necessary to ensure that the child and the parents will co-operate and, as far as possible, to guard against possible psychological disturbances in the child.

For vesico-vagino-rectal fistula resulting from radiotherapy for extensive cancer of the cervix uteri or from actual cancer

In such cases uretero-colic anastomosis would be of no value and the ileal bladder is the best method of relieving the complete urinary incontinence; it may have to be combined with a colostomy if the rectal fistula cannot be repaired.

In cases of pelvic exenteration for extensive pelvic cancer

In a relatively few cases of extensive pelvic cancer originating either in the cervix uteri, the rectum or the bladder and in which the malignant mass is still movable, though the involvement of neighbouring pelvic organs has rendered the more limited formal radical procedures impracticable, pelvic exenteration, removing the rectum and sigmoid, uterus and adnexa, together with the bladder and lower ureters, has been performed. The ureters in such cases have been transplanted into the upper part of the remaining colon, giving the patient a so-called wet colostomy; this, however, is unpleasant and socially difficult to manage.

As an alternative to a wet colostomy, Bricker (1950) advocated the transplantation of the ureters into an isolated loop of ileum brought out as an ileostomy in the right iliac fossa; an end-colostomy is made in the left iliac fossa. In a series of papers Bricker (1950, 1952a, 1952b) and Bricker, Butcher and McAfee (1954) have shown that such a procedure can be carried through so as to give the patient reasonable comfort and enable her to lead an active life, and the authors report a series of 81 cases. The results as far as the ileal bladder is concerned have been very good and there has been a low incidence of hydronephrosis and renal infection and no hyperchloraemic acidosis.

Untreated ectopia vesicae in adults with grossly impaired renal function

In late, untreated, or failed cases of ectopia vesicae in adults, renal function may be very poor because of recurrent attacks of ascending renal infection and subsequent

hydronephrotic dilatation. Moreover, in some cases in this group there is defective tone in the anal sphincter. An ileal bladder after cystectomy is then a more suitable operation than a uretero-colic anastomosis.

Following cystectomy for carcinoma of the bladder as an alternative to uretero-colic anastomosis

The ileal bladder following cystectomy is carried out by a small minority of surgeons who have discarded almost entirely the operation of uretero-colic anastomosis on the ground of its uncertain results. Bricker, Butcher and McAfee (1954) found such satisfactory results following the construction of an ileal bladder in cases requiring pelvic exenteration that they extended its use to cases of carcinoma of the bladder requiring cystectomy; they reported 16 cases. Annis, Hunter and Wells (1954) reported 17 surviving cases in which they had used an ileal bladder following cystectomy for cancer of the bladder. When joining the ureters to the ileum, the techniques of Stiles, Kidd and Coffey were preferred to that of Nesbit which they used in some cases. In discussion of their results they state that they "are utterly opposed to the whole concept of uretero-colic anastomosis". A majority of surgeons still favour uretero-colic anastomosis as the method of choice though some consider that the ileal bladder should be used following cystectomy in patients whose renal function is impaired. It is therefore desirable to refer briefly to the arguments in favour of and against the use of these two methods.

Choice of method

The operation of constructing an ileal bladder together with cystectomy is a very long surgical procedure, tiring to the surgeon and, in some cases, exhausting to the patient, though with modern methods of combating shock and infection it is usually very well borne. It adds to the two uretero-intestinal anastomoses, an ileo-ileal anastomosis, which may be an additional cause of morbidity. Since urine is to drain into a faeces-free cavity usually having a relatively low bacterial content, the incidence of ascending renal infection is not high, though it does occur occasionally. The follow-up pyelograms of the kidneys are satisfactory in a high percentage of cases, as will be seen later. The patient, however, has a permanent urinary fistula through the abdominal wall, which is a drawback. The incidence of hyperchloraemic acidosis is extremely low.

On the other hand, the operation of uretero-colic anastomosis is simpler and shorter than the construction of an ileal bladder, and since 1951 and 1952, when the causes and treatment of hyperchloraemic acidosis, described previously, were worked out, this condition has ceased to be the serious problem that it was prior to those years. Patients look clinically well and provided always that they co-operate intelligently in their own treatment, are able to lead useful lives. Moreover, increasing experience of the operation of uretero-colic anastomosis should lead to better technical results with fewer leaks and fewer strictures. The writer therefore considers that in a case with good renal function, requiring urinary diversion, uretero-colic anastomosis is to be preferred to the operation of the ileal bladder following cystectomy for carcinoma of the bladder.

There remains the difficult problem of which operation to select in cases requiring urinary diversion in the presence of impaired renal function. Many surgeons, including the writer, have transplanted into the colon the ureters of solitary hydronephrotic kidneys following healed vesical tuberculosis, in which renal function was defective, and have obtained good late results, in such cases the dilated ureter allows the easy performance of a Cordonnier mucosa-to-mucosa type of anastomosis. If recurrent attacks of ascending infection occur in such cases, life may be jeopardized, and the ureters may be transplanted into an ileal bladder at a later date, but the arguments

PART I—ORIGINAL ARTICLES

against uretero-colic anastomosis do not seem to the writer to be strong enough to advise the operation of an ileal bladder as the primary procedure in every case which has impaired renal function. In cases with very grossly impaired renal function, however, there is a stronger case for using the ileal bladder instead of uretero-colic anastomosis, since one or two attacks of infection may overwhelm a patient following the latter procedure; on the other hand the construction of an ileal bladder may itself tax the strength of such a patient. The matter, therefore, must be one for the judgment of the individual surgeon having regard to the confidence which he has in his own techniques. Probably there are a few cases in this last group in which an ileal bladder is more suitable than a uretero-colic anastomosis, but a final decision on this difficult matter is not yet in sight.

Some surgeons have argued that if a patient is expected to have many years of survival, for instance, following cystectomy for diffuse papillomatosis of the bladder, the construction of an ileal bladder is a more rational procedure than uretero-colic anastomosis since with the latter procedure slow deterioration in renal function may be expected to occur, such, in fact, is not always the case. The writer would not, therefore, at present accept the argument of possible long-term survival of the patient as being one in favour of the ileal bladder as against uretero-colic anastomosis, though if, in a given case, renal function did deteriorate seriously during the years, the construction of an ileal bladder could then be considered as a secondary procedure.

Preparation of the patient

THE OPERATION

The patient is prepared for operation by being given a low residue diet and 250 milligrams of aureomycin 4-hourly for 4 days before operation; the colon is washed out on the 2 mornings before operation and on the evening before, an enema is given.

The incision

The abdomen is opened by a left paramedian incision, extending from just above the umbilicus to the symphysis pubis. A general inspection of the abdomen is made. The lowest part of the ileum is carefully examined and a suitable coil in the lowest 3 feet of the ileum, about 12 inches in length, is selected, the lower end of the lowest being not nearer than 8 inches from the ileo-caecal valve. The selected portion of ileum must have a mesentery sufficiently long and mobile so that after it has been prepared the distal end of the loop can be brought to lie in the right iliac fossa and pass through the stab opening in the abdominal wall without tension. The first stage of the operation consists in the preparation of the loop. The patient is placed in a moderate Trendelenburg position and the small intestine other than the loop, together with the caecum, are packed away by hot, moist swabs into the upper abdomen. A final accurate estimation can now be made of the length of the ileal loop which is required, having regard to the position of the two ureters which are to be anastomosed to it. If there is any doubt as to whether the two ureters, after division, will lie without tension in relation to the ileum after anastomosis, they can be isolated and divided at this stage of the operation, but as this will leave two small, raw areas and a discharge of urine from the kidneys, it is simplest to divide the ureters after the loop has been prepared.

Division of the ileum

At the lower point selected for the division of the ileum, which is usually 7 or 8 inches above the ileo-caecal valve, the vascular arcade close to the ileal wall is divided between ligatures and the resulting opening in the mesentery is extended at a right-angle to the intestine; usually a second vascular arcade has to be divided so as to give an opening in the mesentery of about 4 centimetres. A lamp held behind

the mesentery by the assistant will help in the identification of the vessels if much fat is present. A second similar opening in the mesentery is made about 14 inches above the first (Fig. 115). The base of the mesentery to the isolated loop should be as wide as possible in order to minimize the chance of rotation of the vascular pedicle. The intestine is then divided between clamps at the selected places; it is convenient to use a Cope's crushing clamp especially for the lower end of the loop since the detachable blades can be left in position after the handle of the clamp has been removed so as to facilitate the passage of the distal end of the loop through the small incision made

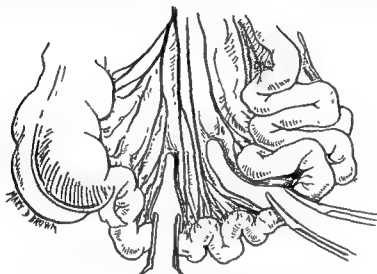


FIG. 115.—Isolation of the ileal loop. The vascular arcades in the mesentery have been divided in order to isolate the loop, and the gut has been divided at the two selected places.

for the ileostomy at the end of the operation. Continuity of the intestine is then restored by end-to-end or lateral anastomosis, in front of the isolated loop (Fig. 116). The opening between the anastomosis and the mesentery of the loop is obliterated by a few interrupted sutures between its anterior leaf and the back of the anastomosis in order to minimize the risk of a prolapse of small intestine through the opening. The proximal end of the loop is closed and infolded unless it is more convenient for the surgeon to anastomose the left ureter to it.

Division of the ureters

The right ureter is mobilized through a vertical incision through the posterior peritoneum at the brim of the pelvis and divided fairly low down, the lower end being ligated. Since it is desirable to implant the ureter some 3 inches from the proximal end of the loop, the internal flap of the divided peritoneum is mobilized by passing a finger beneath it and the divided ureter is then moved nearer to the midline and in close proximity to the proposed point of its anastomosis to the ileum, by bringing it out through a small opening made with fine-pointed scissors in the posterior peritoneum.

The left ureter is similarly exposed through another vertical incision through the posterior peritoneum at the outer side of the sigmoid colon and is divided, the lower end being ligated. It is usually convenient to pass the divided upper end of the ureter through a small opening in the base of the sigmoid mesentery between the vessels so that it emerges on its inner aspect, when it will be found to lie without tension in juxtaposition with the proximal end of the loop. Sometimes the left ureter can be mobilized on the inner aspect of the meso-sigmoid. An alternative method is to allow the ileal loop to lie across the front of the sigmoid colon, joining the upper

PART I—ORIGINAL ARTICLES

divided end of the left ureter to the end of the loop; the disadvantage of this method is that it allows a space between the proximal end of the loop and the sigmoid colon, through which intestine may prolapse.

Anastomosis

The anastomoses of the ureters to the intestine may be made by one of the standard methods previously referred to according to the preference of the surgeon. The left ureter, having been slit up so as to give an elliptical opening, may be anastomosed directly to the end of the loop, in which case the crushing clamp should be left on the

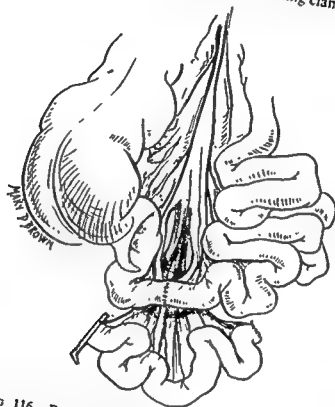


FIG. 116.—End-to-end anastomosis of the intestine to restore continuity. The opening in the mesentery is later closed by stitches. The proximal end of the loop is closed in most cases. Cope's clamp is left on the distal end of the loop.

loop until the surgeon is ready to make the anastomosis. My own preference is to implant the two ureters into the anti-mesenteric border of the loop about 3 and 8 centimetres respectively from the proximal end. Since the ileostomy allows of free drainage of the urine into the bag any back-pressure and reflux of urine to the kidneys should be avoided. I prefer an anastomosis of the Cordonnier or Nesbit type, both of which allow of very free drainage from the kidneys and have less tendency to stricture formation at the anastomosis than the older methods; the ureters are curved round the lower aspect of the ileum and the anastomosis made in front of the loop (Fig. 117).

The Ileostomy Stoma

By placing the ureteric anastomosis in the position named a sufficient length of the ileal loop is left to cross the posterior abdominal wall, to pass round the lateral wall of the right iliac fossa and for the end of the loop to be brought through a small incision in the abdominal wall in the right iliac fossa. This second incision crosses



FIG. 117—Schematic diagram to illustrate uretero-ileal anastomosis. (A) The stoma of the divided upper end of the ureter is cut obliquely to make an elliptical opening (B) Uretero-ileal anastomosis using direct mucosa-to-mucosa technique (Cordonnier's method) (C) Ileal bladder completed and ureters anasto-

the line between the umbilicus and the anterior superior iliac spine at the junction of its outer and middle third, in a position convenient for the Rutzen bag to be fitted over it. The ileal loop is stitched to the posterior peritoneum and to that of the right iliac fossa by a number of interrupted sutures. About one inch of ileum is brought through the abdominal wall, the clamp is removed and the end of the ileum turned inside out and sutured to the skin of the abdominal incision. The main abdominal incision is then closed. A Foley catheter is left in the loop for the drainage of urine for a few days after which a Rutzen bag is fitted over the ileostomy (Fig. 118).

An alternative method of dealing with the ileostomy stoma is the so-called spou-

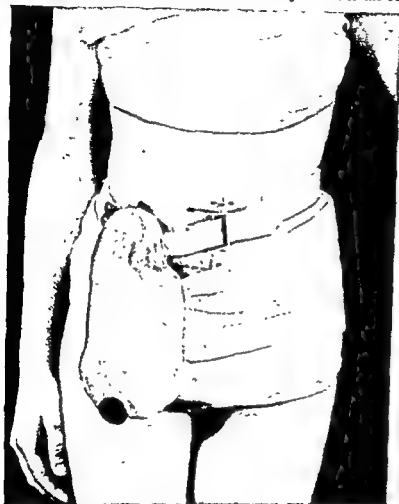


FIG. 118.—Rutzen bag in position over the ileostomy stoma in a case of ileal bladder. The operation here had been done for spina bifida with urinary incontinence.

ileostomy (Wells, 1952) The ileum is brought out of the abdominal opening for a distance of 4–5 centimetres. In order to obtain a downward draining spout the lower surface of the protruding ileum is covered with split-skin graft while the upper surface is covered with a full-thickness skin graft. After healing the graft on the lower surface undergoes sufficient contraction to cause the spout to curl downwards, which enables it to engage in the collecting apparatus.

Complications

The complications are those of the intestinal anastomosis and those of the uretero-ileal anastomoses. Post-operative ileus may be troublesome and calls for a careful watch for, and correction of, electrolyte imbalance and if necessary the use of an indwelling stomach tube and suction drainage. Peritonitis has been reported from

breakdown of the anastomosis; gangrene of the loop and obstruction of the small intestine have been reported; temporary oliguria may occur from oedema of the uretero-intestinal anastomoses though this is not usually serious. Leakage of urine at the site of the uretero-intestinal anastomosis occurred in one of our cases but lasted only for four days and cleared up spontaneously; others have reported the same complication. Acute pyelonephritis may occur but it usually responds to antibiotics; retraction of the external ileostomy stoma has occurred with secondary fistula formation (Bricker, Butcher and McAfee, 1954). If cystectomy or pelvic exenteration is performed at the same time as the construction of an ileal bladder, the operation is correspondingly more severe and the additional complications of those operations may occur.

Collection of urine

The best apparatus for collecting the urine is the Rutzen bag (Fig. 118). The end which fits over the ileostomy opening has a flange which is secured to the skin by a special cement and is re-applied each week. The bag is detachable from the flanged ring secured to the skin, and a clean bag is used each day. In some patients the skin will not tolerate the adhesive cement. In an ambulant patient there is usually no



FIG. 119—Ileal bladder as a reservoir. Cystogram of the artificial bladder made from a long loop of ileum. The ureters have been anastomosed to the ends of the loop. The middle of the loop has been anastomosed to the stump of the prostatic urethra.

leakage. At night the outlet tube at the bottom of the bag can be attached to a long rubber tube which leads to a bottle by the side of the bed.

Late results

The results of the ileal bladder operation are very satisfactory in that the patient feels and looks well, is comfortable and usually achieves urinary continence with the bag and is socially acceptable; most patients are able to return to work. In the Department of Urology at Leeds, 1 death has occurred in 10 cases. The clinical results have been excellent and all the patients have been rendered continent. There has been no hyperchloraemic acidosis in any of the cases and the radiological results of the kidneys are satisfactory.

Bricker, Butcher and McAfee (1954) followed 65 patients in their series of ileal bladder for from 6 to 36 months by means of repeated intravenous pyelograms and clinical observation. Of the 65 patients, 70 per cent were considered to have satisfactory results in that the pyelographic shadows of both kidneys were satisfactory and they were free of clinical evidence of pyelonephritis; 30 per cent were unsatisfactory in that they had either unsatisfactory pyelograms or clinical evidence of pyelonephritis, or both. Eighty-six per cent of the 130 renal units involved in the 65 bladder substitution procedures were either normal or showed a minimal degree of hydronephrosis 6–36 months after operation.



FIG. 120—Post-evacuation film of the ileal bladder showing a little residual urine.

Annis, Hunter and Wells (1954) report the late results of ileal bladders in 15 patients for which 28 ureters were transplanted, followed up for periods of between 27 and 2 months. No patients have complained of renal pain nor have they had renal infection. On intravenous pyelography, 17 were normal post-operatively; 3 which were slightly or grossly dilated or showed no function before operation, 5 showed improvement while 3 showed slightly increased hydronephrosis.

ILEAL BLADDER AS A RESERVOIR

In the operation described above the ileum has been used as a conduit for the drainage of urine. In order to combine the advantage of urinary diversion into the ileum rather than into the colon so as to eliminate or greatly reduce the chances of electrolyte imbalance, and at the same time avoid the social inconvenience of a permanent ileostomy, it has been possible in 2 cases to join the ureters to the ends of a long loop of ileum 22 inches in length and to anastomose the centre of the ileal loop to the prostatic urethra (the bladder having been removed) so as to allow micturition per vias naturales (Fig. 119). This operation has been carried out in 2 cases combined with cystectomy for carcinoma of the bladder (Pyrah, 1956). In one case the patient died from a sudden pulmonary embolism 4 weeks after an operation which was followed by an apparently normal convalescence. Autopsy showed perfectly healed



FIG 121 —Post-operative pyelogram five months after operation for ileal bladder.

anastomoses. The second case, a man aged 54 years, had multiple papillary carcinomas of the bladder which had received treatment first by perurethral diathermy and later by intravesical cavity radium, and this was followed after an interval by radio-necrosis which resulted in persistent and severe haemorrhage. Total cystectomy was performed, removing the bladder, the seminal vesicles and the proximal two-thirds of the prostate, the latter being sectioned transversely so as to leave its distal third for anastomosis to the ileum. An ileal loop 22 inches in length was isolated and intestinal continuity was restored by end-to-end anastomosis. The ureters were anastomosed by a direct mucosa-to-mucosa technique to the ends of the ileal loop. The centre of the loop was anastomosed to the prostatic stump using two rows of sutures, securing a direct union between the mucosa of the ileum and that of the prostatic urethra. *The patient made a good recovery from the operation and is able to micturate normally every 3 hours. When the bladder is full, he has a sensation of fullness in the lower abdomen after which urine is evacuated normally. There is a small amount of residual urine. Cystograms of the new "bladder" before and after evacuation are shown in Figs. 119 and 120. The post-operative intravenous pyelogram 5 months after operation shows no hydronephrosis (Fig. 121); there is no electrolyte imbalance. The patient has been free from recurrence for 12 months and is able to work.*

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HYPOTHERMIC ANAESTHESIA

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Circulatory arrest leads inevitably to oxygen lack in the tissues deprived of their blood supply; if the period of anoxia be prolonged cellular death results. The oxygen requirement of particular cells determines the duration of anoxia they can survive. Cells of the central nervous system are particularly susceptible. In the case of highly developed cells in the human brain a period of 2-4 minutes' circulatory arrest leads under usual conditions to permanent cerebral damage. For example, in cases of cardiac arrest the heart may be restarted by cardiac massage, but often, because of delay, so much brain damage has occurred that consciousness is never regained.

If the body temperature be lowered cellular metabolism and oxygen demand are reduced, so that cells may survive anoxia for longer periods. It has been shown in animals that at body temperature below 25° C the circulation to the brain may be arrested for 20 minutes and yet complete recovery may occur, there being no physiological or histological evidence of cerebral damage. At these temperatures coronary vascular occlusion was fatal, a reversal of the normal finding that the heart withstands anoxia better than the brain.

It follows from these observations that hypothermia might permit the performance of certain operations which would be impossible at normal temperatures owing to anoxic cellular death (Swan, 1954). Procedures in which a hypothermic technique might be of value are described.

CARDIOVASCULAR SURGERY

Direct repair under vision of cardiac abnormalities

This group includes intracardiac procedures (Brock, 1956) upon the open dry heart, with temporary occlusion of the venae cavae and cessation of the circulation; for example, for the repair of septal defects and certain valvular abnormalities.

Operations on the great vessels

This applies to such operations as necessitate circulatory occlusion; for example, certain operations for transposition of the great vessels.

Operations for congenital cyanotic heart disease

Although circulatory arrest is not usually essential in these cases, hypothermia reduces the oxygen demand and the anaesthetic requirements. This indication for

advise against the technique, believing that the danger of ventricular fibrillation outweighs the slight advantage such cases may gain (Gray, 1955).

PART II—CRITICAL SURVEYS

NEUROSURGERY

It is evident that hypothermia might be of advantage for intracranial procedures involving temporary arrest of the circulation to part of the brain. In this connexion it has been suggested that hypothermia might increase the margin of safety in induced hypotension for neurosurgical operations. Rosomoff (1956) has summarized the possible advantages of hypothermia in this field, and has presented convincing evidence that occlusion of the middle cerebral artery is well tolerated in experimental animals (Rosomoff, 1955) under hypothermic conditions. It might, therefore, be anticipated that hypothermia would protect against the sequelae of "retractor ischaemia" of the brain and of operations involving internal carotid artery occlusion. Hypothermia reduces brain volume: at 25° C intracranial space not occupied by brain is increased by 31.8 per cent (Rosomoff and Gilbert, 1955). The accompanying arterial hypotension may also facilitate neurosurgical procedures (Rosomoff and Holaday, 1954).

AORTIC GRAFTING PROCEDURES

In operations for aortic aneurysm involving excision and replacement by graft or plastic tube the level of circulatory occlusion is important. If this is high enough to involve ischaemia of the spinal cord, neurological damage will ensue unless the procedure be performed under hypothermic conditions. Rob and Eastcott (1955) have reported a series of such cases and the anaesthetic management has been described (Cheattle, 1955); in one centre hypotension has been induced with Arfonad during hypothermia (Julian and his colleagues, 1955).

MISCELLANEOUS PROCEDURES

Some workers have claimed that under hypothermic anaesthesia operative shock can be avoided during very radical surgery (Gray, 1955, Murray, 1955). It has also been suggested that hypotensive anaesthesia may be safer under hypothermic conditions (Dundee, Francis and Sedzimir, 1954); various therapeutic applications of induced hypothermia have been reported (Gray, 1955; Sedzimir, Jacobs and Dundee, 1955).

THE ADVANTAGES ACCRUING FROM THE HYPOTHERMIC STATE

These are discussed by Delorme (1955).

Reduced oxygen requirement

Provided shivering be prevented, the oxygen consumption falls in a linear fashion with the reduction of body temperature. At 30° C the oxygen requirement is reduced to 55 per cent and at this temperature the blood pressure is usually well maintained. At 20° C oxygen consumption is approximately 15 per cent of normal (Bigelow, Mustard and Evans, 1954) and Lynn and his colleagues (1954) suggest that it would be almost zero in dogs at 10° C.

Reduced cardiac activity

Aerobic energy uptake, and to a greater degree left ventricular work, both decline (Edwards and his colleagues, 1954).

Increased coagulation time

In vitro at 20° C coagulation time is approximately trebled (Macfarlane, 1948). Under hypothermic operation conditions there may also be a fall in the number of platelets and in prothrombin formation by the liver. These effects may lead to serious retardation in clotting and result in post-operative haemorrhage, but some benefit is possible, too, as thrombosis is an accepted complication of some cardiovascular operations.

Reduced anaesthetic requirements

It is reported that below 27° C consciousness is lost, the hypothermia of itself inducing the anaesthetic state.

Harmful bacterial and enzyme activity is suspended**DANGERS OF THE METHOD****The cold stress response**

This is discussed by Delorme (1953). It is manifested by endocrine activity and shivering; the latter giving rise to impulses which can be observed on the electrocardiographic record. At the start of cooling there is increased sympathetic action with release of adrenaline. Vasoconstriction results and tends to retard heat loss, the efficiency of surface cooling being notably impaired. A more rapid fall of surface compared with rectal temperature is an index of this vasoconstriction, and some workers (Gray, 1955) regard this as an indication for giving a vasodilator such as chlorpromazine. During cooling there is increased production of ACTH and of thyrotropic hormone which tends to raise heat production; even in the absence of shivering some initial rise in oxygen consumption is possible, especially with surface cooling.

The muscular activity involved in shivering leads to an increase in heat production and oxygen demand; this process can for a time prevent a fall in temperature in the initial stages of the cooling procedure. Shivering can and should be prevented by anaesthetics, by muscle relaxants, and by chlorpromazine. This last agent is particularly effective in helping to lower body temperature, which it does by decreasing heat production in voluntary muscle, by producing vasodilatation and so promoting heat loss and, possibly, by an effect on the temperature-regulating centre. In addition to these effects chlorpromazine has a wide range of pharmacological activity. It is not essential to the hypothermic technique.

Tissue injury due to cold

In surface cooling methods tissue injury can be prevented by avoiding extreme degrees of cold. It is unfortunate that infants are especially liable to subcutaneous fat necrosis under these conditions because infant fat has a relatively higher melting point (Collins, Stahlman and Scott, 1953). Precautions must also be taken to avoid thermal damage during rewarming.

Effects on vital organs

Certain histopathological changes in vital organs (liver, kidneys, adrenals) have recently been reported in dogs subjected to hypothermia (Knocker, 1955). These results have not been confirmed elsewhere and the significance of the changes remains to be assessed, it must be pointed out that certain features of the anaesthetic and cooling methods employed in this work, and especially the prevalence of untreated respiratory depression, are not in accord with clinical practice. An increasing number of successful cases operated upon during hypothermia implies that damage to vital organs does not constitute a serious objection, and post-mortem findings in fatal human cases do not support the histological findings quoted above. Brewin, Nashat and Neil (1956) have recently reported that in animals under hypothermia circulatory arrest for 10 minutes produces a severe derangement of liver function and structure; on rewarming, liver function is not improved. These effects may be caused by the marked rise in central venous pressure due to the circulatory occlusion: if this rise in venous pressure be prevented, the liver damage may be avoided and the function on rewarming is then apparently normal. With regard to the brain, there is electroencephalographic depression during hypothermia, but there is ample evidence that the changes are reversible and that cerebral function is unimpaired on recovery (Callaghan and his colleagues, 1954).

Changes in the blood

Alterations in acid-base equilibrium

At low temperatures the carrying power of the blood for carbon dioxide is increased owing to reduced ionization of haemoglobin and protein. The solubility of carbon dioxide in blood is increased at lowered temperatures, but this does not lead to a gaseous acidosis because its effect on pH is offset by the increased bicarbonate carriage.

Respiratory activity diminishes as the temperature falls and as a result carbon dioxide retention occurs; the resulting fall in pH may be in part the cause of ventricular fibrillation. This gaseous acidosis can be prevented by hyperventilation, which should therefore always be performed during hypothermia. With hyperventilation the blood pressure (and so presumably coronary flow) is better maintained as the temperature falls and, experimentally, survival to lower temperatures is possible before cardiac arrest occurs (Lynn and his colleagues, 1954). It is possible that positive/negative pressure ventilation is advantageous during hypothermia because, in addition to efficient hyperventilation being secured, a rise in venous pressure is prevented.

A metabolic acidosis also occurs during hypothermia (Brewin, Nashat and Neil, 1956); this is associated with a raised blood lactate concentration and is especially severe in cases subjected to circulatory arrest. The causes include generalized circulatory insufficiency and an impaired ability of the liver to metabolize lactate: derangement of the liver function has already been noted. Brewin and his colleagues suggest that this metabolic acidosis can be treated by intravenous administration of a calculated dose of sodium bicarbonate.

Increased viscosity

Increased viscosity occurs in the first place as a simple physical effect of cooling the blood, and secondly as a result of the haemoconcentration which accompanies the induction of hypothermia. In cases of congenital cyanotic heart disease the blood is already very viscous—the haemoglobin may be 140 per cent—and this effect is especially undesirable. Coupled with the vasoconstriction which accompanies cooling, the increased viscosity leads to elevation of the peripheral vascular resistance, so adding to the work of the heart.

Impaired coagulation

This may lead to serious post-operative haemorrhage; the causation has already been outlined

Oxyhaemoglobin dissociation

At low temperatures oxyhaemoglobin dissociates at relatively lower partial pressures so that, theoretically, it is harder for the tissues to obtain oxygen. This effect may be offset by reduced tissue oxygen demand and would be mitigated by any alteration in pH towards the acid side.

Electrolyte changes

The interrelation between carbon dioxide carriage and ionic equilibrium in the blood has already been mentioned. Varying effects during cooling on sodium, potassium and other ions have been reported, possibly depending on the adequacy or otherwise of ventilation during the observations. Churchill-Davidson (1955) reviews these reports and mentions a rise in plasma calcium levels at temperatures below 25° C, which may effect the heart.

The elimination of non-volatile anaesthetic agents

The elimination of non-volatile anaesthetic agents is greatly retarded, presumably in association with the reduction in metabolism. There is a linear fall in renal blood flow and excretion as the temperature falls (Churchill-Davidson, 1955).

As already noted, anaesthetic requirements are reduced in the hypothermic state: consciousness is lost at about 27° C and respiratory arrest may occur at 23–25° C. Barbiturates and other respiratory depressants will predispose to respiratory arrest at relatively higher temperature levels. Because of these considerations, drugs such as thiopentone and pethidine should be used in minute amounts and the dose of post-operative sedatives should be reduced.

The reaction to relaxants may be altered by profound changes in body temperature (Quilliam and Taylor, 1947; Dripps, 1955). During hypothermia the action of depolarizing agents is enhanced and prolonged, whereas the effects of those relaxants producing non-depolarization block are somewhat antagonized (Zaimis, E. J., personal communication). The observation of Brown (1954) that acetylcholine secretion at the synapse is depressed may be of importance in this connexion.

The metabolism of glucose, also, is retarded during hypothermia. Wynn (1954) has reported a blood glucose level of over 1,000 milligrams per 100 millilitres during hypothermic anaesthesia; there was a concomitant serious fall in plasma electrolytes. For this reason a glucose solution should be used very sparingly, if at all, for the intravenous drip.

Cardiovascular system

As body temperature falls the heart rate, cardiac output and arterial blood pressure all decrease. For example, in dogs at 20° C the cardiac output may be only 15 per cent of normal. In proportion, the arterial pressure falls less than the other two factors. The mean arterial pressure is the product of the cardiac output and the peripheral resistance and, although the cardiac output falls with the temperature, the peripheral resistance is increased, as already noted. As a result the arterial pressure may fall only slightly until 30° C or less, but it may drop sharply in the region of 25° C. In contrast the venous pressure may rise during hypothermia, this effect being mitigated when positive/negative pressure ventilation is employed. During the period of circulatory arrest the central venous pressure may be greatly elevated; Brewin, Nashat and Neil (1956) suggest that this may be the cause of liver damage; measures to prevent this venous congestion are described and these are capable of alleviating the effects on the liver. Gray (1955) reports that during hypothermia in adult dogs the cardiac output is not maintained at high venous flows, that is, Starling's law no longer applies. The coronary flow falls to a greater extent than the blood pressure, the implication being an increase in the ratio of cardiac work to coronary flow. After initial acceleration when cooling begins the heart rate decreases in a regular and linear fashion as the temperature is reduced; at temperatures below 25° C in man ventricular fibrillation may occur abruptly. The pulse shows a linear fall in rate, which is not abolished by vagal paralysis and is therefore presumed to be due to a direct effect on the pacemaker. A bradycardia of 30 per minute is common during operations under hypothermia, the process of cardiac contraction is slowed; typical electrocardiographic changes are shown in Fig. 122. As the temperature falls to critical levels extreme bradycardia (Cookson, Neptune and Bailey, 1952) or cardiac irregularities may occur; therefore electrocardiographic control is essential throughout these procedures. Cardiac irritability appears to be increased and direct surgical stimulation of the heart may provoke ventricular fibrillation (Lynn and his colleagues, 1954; Swan, 1954).

As further cooling takes place spontaneous ventricular fibrillation or cardiac standstill occurs and may cause death in progressive hypothermia. Dogs appear more liable to this event than human beings; in fact there is a great species variation in the temperature level at which this complication is encountered; in rats it may not happen until 12° C or lower (Lancet, 1954), but in adult man it is likely to occur in the region of 25° C. Fortunately infants and young children are more resistant than adults in this respect, and it is in such young patients that the method has so far

found its most frequent application. In those with acquired heart disease (for example, previous rheumatic carditis) the liability to ventricular fibrillation is said to be increased and the method is regarded by some as contra-indicated in such patients (Bailey and his colleagues, 1954; Gray, 1955).

The exact cause of ventricular fibrillation during hypothermia is imperfectly understood. Lange, Weiner and Gold (1949) blamed anoxia and reported amelioration with high oxygen tension: these findings have not been confirmed. Other workers blamed the reduced coronary blood flow, measures designed to improve it having a protective effect (Ross, 1954a). The remarkable revival of heart beat in the cadaver by coronary perfusion reported by Kountz (1936) is of interest in this connexion. Others suggest that the fall in pH is responsible (Fleming, 1954) and it has been observed that hyperventilation has a preventive influence (Swan and his colleagues, 1953; Lynn and his colleagues, 1954; Fleming, 1954). There have also been reports

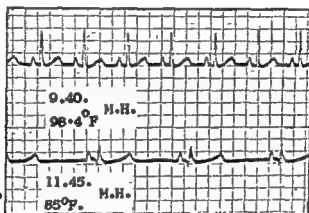


FIG. 122—E.C.G. lead 2: bradycardia at 85° F.
(By courtesy of the Editor of the "Proceedings of the Royal Society of Medicine")

that a sudden fall in an abnormally high blood carbon dioxide level can precipitate fibrillation in the dog (Miller and his colleagues, 1952; Swan and his colleagues, 1953). Electrolyte changes may be implicated, but the evidence is contradictory. Sealy, Young and Harris (1954) noted that post-hypercapnic fibrillation is associated with increased serum potassium—improvement resulted from giving sodium and glucose. By contrast, Swan and his colleagues (1953) and Zeavin, Virtue and Swan (1954) reported a fall in serum potassium during cooling and used potassium chloride

potassium
ris, 1954).
a technique
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potassium concentration and

the heart beat recommences.

Some workers (McMillan and his colleagues, 1955) have observed a rise in plasma calcium levels below 25° C, the calcium/potassium ratio being increased. Melrose (cited by Churchill-Davidson, 1955) produced evidence that this increase in ionized calcium could produce a current of injury potential in the electrocardiogram; such a change in the region of the S wave appeared to be a precursor of ventricular fibrillation. Conversely, Swan and his colleagues (1953) have used calcium chloride successfully to treat cardiac arrest in a hypothermic patient. Another suggested factor is that during hypothermia acetylcholine production is depressed (Brown, 1954), so that the pacemaker losing its dominance, ectopic foci tend to arise. In keeping with this, Swan (1954) and Prevedel, Montgomery and Swan (1954) reported that prostigmine introduced into the coronary circulation had a powerful protective effect against

fibrillation; Delorme (1955) has published records showing inhibition of cardiac activity by prostigmine with abolition of its effect by atropine in the hypothermic dog.

It is of interest to note that hibernating animals can be cooled to 4° C (Juvenelle, 1954; Burton and Edholm, 1955), a temperature which in the non-hibernator would certainly lead to ventricular fibrillation; Smith (1954) has reported revival of golden hamsters from body temperatures below 0° C. As previously stated, infants and young animals withstand cooling much better than adults. From these considerations it seems likely that the basic cause of fibrillation is connected with the qualities of inherent cardiac rhythmicity and conductivity. It is possible that drugs may be developed (Cookson, Neptune and Bailey, 1952; Sealy, Young and Harris, 1954) which will prevent this complication arising; Cookson (1956) states that certain quaternary compounds increase the liability to it.

Should ventricular fibrillation occur, repair of the cardiac defect is immediately performed if the operation has progressed sufficiently. Cardiac massage is then undertaken and when the heart muscle is seen to be well-oxygenated and its tone has increased, defibrillation is attempted by means of repeated brief electrical shocks of 1.5-2.0 amps. Brewin (1954) has advocated the injection of 1 millilitre of 1 : 3,000 adrenaline into the ventricular cavity, followed by massage, when cardiac tone improved a single one-fifth second shock of 1 amp. was given: after a short interval a co-ordinated beat reappeared.

Potassium and calcium solutions have also been employed with success, Swan using potassium chloride to arrest fibrillation and following with calcium chloride to restart the heart. On occasion an electrical artificial pacemaker may be useful.

After-cooling

Despite the cessation of cooling the temperature of the subject continues to fall for 30 minutes or more, depending on the physique of the patient. If this is not anticipated, the desired level may be overshoot (Scurr, 1955). This drift is probably more marked after rapid cooling by immersion in a bath. Gray (1955) advises changing the patient's position every 15 minutes during surface cooling in order to lessen the pooling of cooled blood in any one part of the body, with the aim of reducing the extent of the after-drop. In the rewarming period "after-cooling" may occur, this is presumably due to opening up of the circulation in the very cold outer shell of the body (Burton and Edholm, 1955), very cold blood from the periphery thus entering the main circulation. This further fall in central temperature may lead to fatal ventricular fibrillation. It is obvious that the danger of this after-drop will be greater in methods involving surface cooling than in extra-corporeal cooling of circulating blood.

The fact that temperature gradients can be set up in the body raises the question of the best site at which to assess the body temperature. Many workers have hitherto observed the rectal temperature by means of a thermocouple; there is ample evidence that this does not provide an accurate guide to the central body temperature (Gerbrandy, Snell and Cranston, 1954). It is obvious that the cardiac temperature is of the greatest importance and pharyngeal or oesophageal temperatures are more reliable guides to the degree of cooling. A thermocouple for the brain has recently been devised.

Limit of time available

The studies on the heart imply that at the present time 25° C is the lowest temperature that can be induced with relative safety. This factor limits the time available for circulatory arrest if anoxic sequelae are to be avoided, and Bigelow, Mustard and Evans (1954) have tabulated the period of circulatory interruption and the concomitant body temperature likely to be required for various procedures. Brock (1956)

accepts a limit of 10 minutes arrest at 28° C. Bailey and his colleagues (1954) have reported a case of complete circulatory interruption in an infant for 22 minutes at 21·6° C: there was no evidence of cerebral damage 30 hours after operation. Rob (1955) has described an operation under hypothermia in which occlusion of the thoracic aorta for 2 hours was followed by definite but minimal signs of cord damage.

It is thus seen that the usefulness of hypothermia in the direct repair of cardiac defects is limited by the short period of time which it affords for the procedure; this technique is thus likely to be supplanted when a successful pump-oxygenator is developed to permit of cardiac by-pass.

METHODS OF INDUCING HYPOTHERMIA

Surface cooling

The patient may be immersed in a bath of cold water (Virtue, 1955) or ice packs applied to the surface of the body (Gray, 1955). In other centres a special cooling blanket is used to cover the patient; water at a temperature of 2-4° C is circulated by means of a pump through tubes incorporated in the blanket (Ingles, Biffen and d'Abreu, 1954; Scurr, 1955). The apparatus used is shown in Fig. 123. The patient is anaesthetized and intubated in the usual way and then placed on the cooling blanket. The electrocardiographic leads are attached and an intravenous drip is set up. Instruments for observing the body temperature are inserted into the pharynx or oesophagus, and the rectum (the unreliability of the latter site has been noted). A mercury-in-glass or, more conveniently, a long mercury-in-steel thermometer may be used. Alternatively, a thermocouple or resistance thermometer may be chosen. Whatever

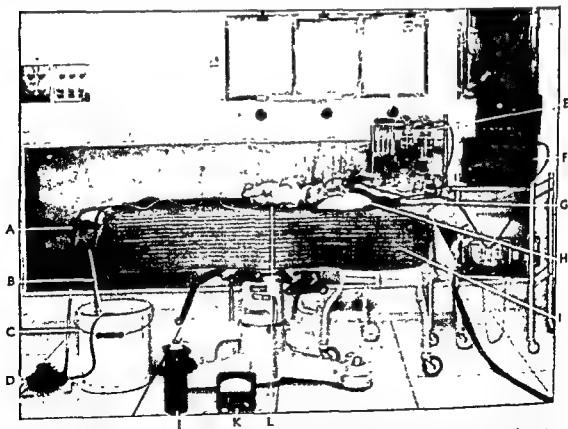


FIG. 123.—Apparatus for hypothermic anaesthesia. A.—Blanket inflow. B.—Outflow thermometer. C.—Reservoir. D.—Pump. E.—Anaesthetic machine. F.—E.C.G. apparatus. G.—Breathing bag. H.—Carbon dioxide absorber. I.—“Freezing blanket”. J.—Zero junction. K.—Galanometer, and L.—Rectal junction: thermocouple.

(By courtesy of the Editor of the “Proceedings of the Royal Society of Medicine.”)

instrument is selected, it must be carefully calibrated against a standard thermometer, as errors in temperature level may have serious consequences. Ordinary clinical thermometers are inadequate in range.

The blanket is closed and the circulation of cooling fluid is continued. Light anaesthesia is maintained, for example with cyclopropane or ether and oxygen, or thiopentone, nitrous oxide and oxygen, with a relaxant so as to prevent shivering. The assistance that chlorpromazine affords to cooling has already been pointed out. At 27° C the anaesthetic may be discontinued and 100 per cent oxygen used for the inflation; shortly afterwards the operation is begun, relaxants being given as necessary

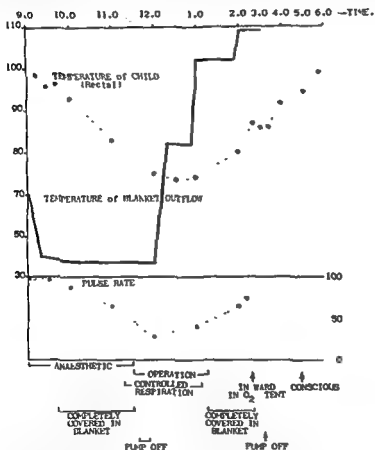


FIG 124—Chart of Blalock's operation on child aged 5 years
(By courtesy of the Editor of the "Proceedings of the Royal Society of Medicine")

during the thoracotomy. At the start of cooling there is usually some apparent increase in respiratory activity. Later, respiratory depression occurs—the temperature of respiratory arrest varies, being higher in proportion to the previous administration of respiratory depressant drugs. During cooling adequate controlled respiration should be started as soon as respiratory depression becomes evident. During emergence respiratory activity usually returns at a lower temperature level than that of apnoea during cooling. It is worth noting that the pupils are widely dilated throughout the hypothermic period. The temperature variations are shown in Fig. 124, which records the course of a Blalock's operation on a child aged 5 years.

Surface cooling methods are slower in action and liable to the dangers of cold injury, of shivering and the development of thermal gradients and overshoot; it is also probable that metabolic changes and haemoconcentration are more marked. The technique is, however, simple and avoids cannulating an artery with the attendant

threat to a limb. In small infants the cannulation may be a difficult undertaking and in such cases surface cooling may be preferable.

After the cardiac procedure is completed rewarming is allowed to occur; in some centres (Scurr, 1955) warm water is circulated through the blanket. An alternative is to immerse the patient in warm water after the chest has been closed. Other workers prefer merely to cover the patient with warm blankets and allow the patient to rewarm slowly; it seems desirable, however, to elevate the body temperature above the danger zone as rapidly as possible—once 30° C has been attained the patient may be returned to bed. Rapid rewarming has dangers of its own; a serious after-drop is a possibility, widespread vasodilatation may lead to circulatory collapse, and thermal damage may result from over-zealous rewarming. The short-wave diathermy can be used to promote rewarming (Virtue, 1955) but, again, care must be taken to avoid burning.

Body cavity cooling

This method is akin to surface cooling; it has been briefly reviewed by Delorme (1955).

Extra-corporeal bloodstream cooling

This involves circulating blood from an artery (for example, the subclavian or femoral) through a length of plastic tube immersed in a cooling mixture and returning the blood into a vein (saphenous) (Delorme, 1952). In other centres, a vein-to-vein circulation incorporating a pump has been used (Ross, 1954b). Extra-corporeal cooling is more rapid and also saves time by enabling cooling to proceed *pari-passu* with the opening of the chest or even after the chest has been entered and the diagnosis established by examination of the heart (the procedure being safer on the normothermic heart—fibrillation may be provoked during hypothermia). In view of the metabolic changes which have been enumerated it is highly desirable to reduce the cooling period to the minimum in this way. An additional advantage of this plan is that cardiac massage is immediately possible if cardiac arrest or fibrillation occur; furthermore, rewarming of the circulating blood is feasible and leads to early elevation of cardiac temperature.

Arteriovenous cooling

This

and by

Briefly,

which is immersed in circulating ice-water. The smooth, non-wettable surface obviates the need for anticoagulants. The cooling coil functions as an arteriovenous shunt and thus imposes an extra load on a pathological heart. In spite of excision of the damaged segment, arterial thrombosis might follow this procedure. As the cardiac output falls with the temperature the flow through the coil diminishes, resulting in progressive slowing of the cooling process. Physical calculation of the number of calories of heat to be removed to produce a stated temperature drop in a subject of given body-weight gives an impressive figure, which is a guide to the magnitude of the problem of heat abstraction in this manner.

Venous cooling

Some of the disadvantages of arteriovenous cooling have been overcome in the method devised by Ross (1954b). As originally applied, blood is sucked from a catheter in the superior vena cava, pumped through the cooling coil and returned to the inferior vena cava. A simple hand-driven rotary pump is used. In the latest form of venous cooling, after opening the chest both cannulae are introduced through the right atrium into the venae cavae; Brock and Ross (1955) give an excellent and

detailed description of the technique. They point out that venous rewarming is possible by inserting fresh cannulae through the right atrial appendage and pumping blood through the coil, which is immersed in warm water at 40° C; surface rewarming is used in addition.

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PARTIAL NEPHRECTOMY

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HISTORY

Partial nephrectomy became recognized as a possible procedure in the treatment of localized renal disease during the latter part of the nineteenth century, but it soon fell into disrepute because of numerous failures, due partly to faulty surgical technique, partly to inaccurate or incorrect diagnosis and a wrong selection of cases. With the advent of x-ray and new and thorough methods of urological diagnosis, this operation has steadily become more popular and in recent years, as a result of better understanding of the basic principles involved, has become recognized as the best method of treating certain diseases of the kidney.

DEFINITION

The term partial nephrectomy means the removal of a portion of a kidney, usually a single pole, occasionally both poles, and rarely the central part alone or in combination with a pole. At least one-third of the kidney must be retained and must be capable of functioning satisfactorily. The part thus removed may contain part of the pelvi-calyceal system, or may consist solely of renal cortex, as for example after excision of a solitary cyst. Calycectomy or calyx resection and papillectomy are included in the general term partial nephrectomy.

Partial nephrectomy must not be confused with heminephrectomy which implies the removal of one complete unit, for example "half" of a congenitally anomalous double kidney or of a horse-shoe kidney.

The operation is performed by the excision of a wedge or by straight section. In the treatment of calculi the operation should be performed with the axis of section placed as depicted in Fig. 125a. All the minor calyces of a pole can then be removed and if the surgeon desires when the operation is performed on the lower pole, the incision can be enlarged medially into the pelvis to permit extraction of pelvic calculi.

INDICATIONS

Localized renal calculi

Aetiology of primary renal stone

In order to understand the basic principles involved in the treatment of primary renal calculi by partial nephrectomy, the surgeon should be acquainted with the recent views on the aetiology of calculi.

Stones in the kidney can be divided into two groups. (1) primary; and (2) secondary. The primary stones originate in the renal cortex, the secondary ones in the pelvi-calyceal system as a result of stasis, infection and the like.

Primary stones.—Although it is wise at this stage of our knowledge to classify primary stones from the aetiological point of view into two groups, it is not unlikely that the fundamental explanation of both groups may lie in the lymphatic theory of causation.

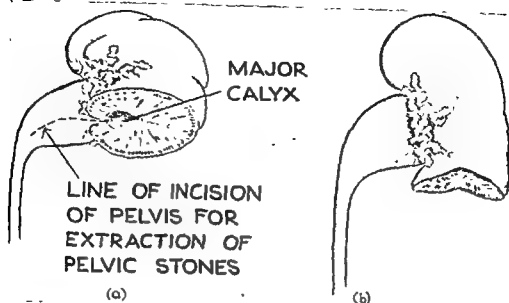


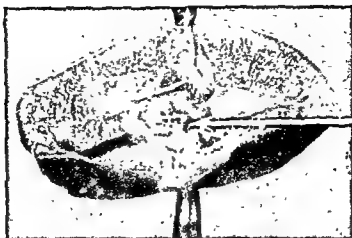
FIG 125(a) and (b).—Wedge or cuneiform resection of the kidney.

Randall's stones (1937) which form on calcified plaques on a papilla (Fig 126a, b, and c) Calcareous material deposited beneath the epithelium and between the collecting tubules causes atrophy and destruction of the epithelium; the calcareous material becomes bathed in urine, and deposition of further salts occurs on the exposed surface and a stone develops which at first is adherent to the papilla.

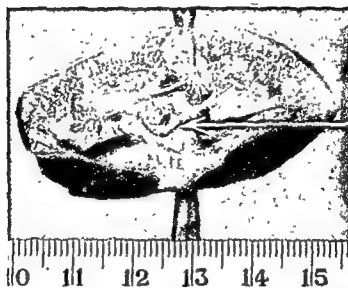
Carr's stones (1954) form from small calcified bodies he called "concretions" which occur singly or in small clusters just outside the fornices of the calyces (Fig. 127a and b). The cavities in which they lie are separated from the fornices by only a thin membrane and he considered that these small cavities or "pouches" were dilated lymph vessels. This dividing membrane can rupture completely and allow the concretions to escape but if the rupture is incomplete, urine can leak into the pouch and urinary salts are then deposited around these concretions. They may thus be held together and form a single stone with multiple concretions as the nucleus, or a single concretion may grow into a stone.* Anderson (1946) and Carr (1954) also showed that deeper in the kidney substance of the involved segment were similar but smaller calcified bodies or microliths. Carr postulated that any intrarenal calcific deposits or other debris, within or without the tubules, were removed *via* the lymphatics and that stones form as a result of a breakdown in this mechanism. In the ordinary run of cases of primary renal stone, this breakdown is probably due to a fibrosis from previous inflammation, and usually only a single segment of the kidney is involved. In general metabolic diseases, and in primary tubular defects, calcific deposits occur usually throughout both kidneys, and it seems likely that in such cases the whole lymphatic drainage mechanism breaks down on account of being overloaded. In such cases, tubular calcification may be prominent as is shown in Fig 128.

A primary stone having developed in the way described may remain in the calyx and gradually increase in size. It may enlarge through the neck of the calyx into the pelvis and in due time a staghorn calculus may result. It may on the other hand mature in the calyx and later be extruded into the pelvis and increase in size there if it is not passed down the ureter. Alternatively, the primary stone or stones may pass down the urinary tract and if they are large enough, renal colic will result. If the

* Occurrence of stones with multiple spherical bodies as a nucleus has now been confirmed by Prien (1955), who concurs that Randall's theory (1937) cannot explain them.



(a)



(b)



(c)

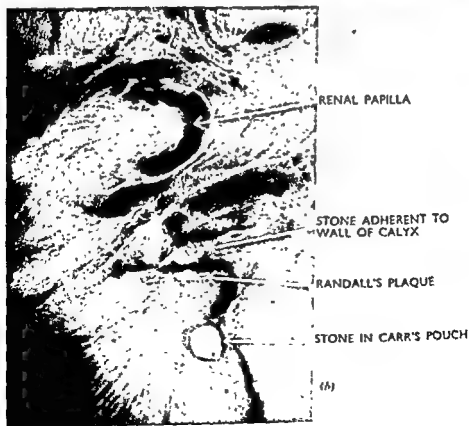
FIG. 126—(a) Calculus adherent to Randall's plaque; (b) Randall's plaque after removal of calculus; (c) microradiograph of Randall's plaque.

FIG 127 —(a) Stone lying in Carr's pouch (b) Micro-radiograph showing early stone formation

*By courtesy of Dr R J Carr
(These two photographs are also by courtesy of the Editor of the British Journal of Urology)*



(a)



(b)



(a)



(b)

FIG 128—(a) Tubular calcification and calculus in pelvis of kidney
(b) Nephrocalcinosis
(By courtesy of the Editor of the British Journal of Urology)



(a)



(b)

FIG. 129—(a) Hydrocalyx due to calculus impacted in neck of a major calyx. (b) Hydrocalycosis affecting minor calyces of upper pole due to impaction of a calculus in the major calyx. At the time of x-ray examination the stone had passed down into the upper ureter. (c) An infected right upper calyx containing granulation tissue—this calyx previously contained a calculus—condition responsible for persistence of urinary infection.



(c)



(a)



(b)

FIG. 130—(a) Microliths in the interstitial tissue—no surrounding inflammatory reaction. (b) Squamous metaplasia.

stone is a Randall's stone then the calcareous material on the papilla may be carried off with it and healing of the papilla may later result. In the case of a Carr's stone, the pouch may be emptied of its concretions and may now become part of the calyceal system. It is evident, however, in both cases, that calcareous material may be left behind and serve as a basis for further stone formation. Moreover, the segment of the kidney which is stone forming and pathological remains, and further stones may thus develop many years later. It is thus clear that in the surgical treatment of primary stone in the kidney the affected segment or segments should be removed if recurrence is to be avoided.

Pathological changes in the kidney

The gross pathological changes in the renal tissue are principally dependent either upon the degree of obstruction caused by the calculus to the outflow of urine, or on anatomical or intrinsic pathological changes in the calyx and its infundibulum. The calyx becomes dilated and a gradation occurs between caliectasis and hydrocalycosis. In the latter condition the calyx may be transformed into a cyst which, on occasions, may become very large. If the calculus is impacted in the major calyx, the minor calyces may be grossly dilated. A small opening, however, can usually be found communicating with a major calyx or the pelvis. Fig. 129a and b depicts these appearances.

The dilated calyx or calyces in some cases become infected, either from the blood stream or, less often, from an ascending infection from the lower urinary tract. Ureteric catheterization carried out with faulty technique or on unsuitable cases may have the same result. When infected, the calyceal cavity contains purulent urine and inflammatory changes are seen in the surrounding kidney tissue. This focus of infection is one of the causes of recurrent urinary tract infection, and until it has been removed permanent sterilization of the urinary tract, even by the use of antibiotics, is very unlikely to be achieved. Although a calyceal calculus may pass down the urinary tract, infection may persist in the dilated pathological calyx which remains. Pyelograms of such a case (Fig. 129c) are shown in which a subsequent nephrectomy was performed and infection demonstrated by pathological examination.

Microscopic examinations of specimens removed by partial nephrectomy for the treatment of renal calculi were carried out. The microphotographs (Fig. 130a and b) show microliths and squamous metaplasia. Microliths were found in 75.8 per cent of the specimens examined, and were present in the interstitial tissue without any surrounding inflammatory reaction. Some of them were seen to project into the collecting tubules. Squamous metaplasia of the pelvi-calyceal lining was seen in 23.3 per cent of the specimens. This change may be due to mechanical irritation from the stones, or to vitamin A deficiency, but the aetiology has not been determined with certainty.

Microradiography and diffraction analysis

Carr examined by microradiography many of these specimens, and also kidneys obtained from the post-mortem room. He observed the presence of microliths and also larger calcified bodies which he called concretions lying in pouches in relation to the fornices of the calyces. He postulated that these calcified bodies were located in the lymphatics. He showed that in any one case the microliths, concretions and the primary stone in the pelvi-calyceal system were composed of the same substance. He moreover demonstrated the presence of the same substance in bodies located in the peripelvic fat. Fig. 131, which was made by Dr Carr, illustrates a stone removed by the author.

Observations on partial nephrectomy in the treatment of renal calculi

The author observed before 1938, as a result of repeated skiagrams taken over a prolonged period of time, that recurrent primary stones matured in the same part



FIG. 131—Top right shows a large stone from the kidney of a girl aged 20 years. Bottom right is a micro-radiograph of a piece of fatty tissue containing a concretion from outside the pelvis of this kidney. On the left are the diffraction patterns of each, showing that they are identical substances.

(By courtesy of Dr R. J. Carr and the Editor of the British Journal of Urology.)

of the kidney, usually in the lowest minor calyx. As a result of this observation he carried out a series of partial nephrectomies and the affected calyx and calyces were removed.

The cases were followed up radiographically in 1952, and then again a final series was investigated in 1955. The recurrence rate following 152 partial nephrectomies observed over a period of 16 years was 7.9 per cent. A study of the recurrent cases revealed that in all but one, the recurrence had occurred in the lower pole and was located in a minor calyx or in the truncated major calyx which had not been removed at the time of the partial nephrectomy (Fig. 132).

It thus appeared that if recurrence of a primary calculus were to be prevented then the major calyx with all its associated minor calyces must be removed in a lower polar partial nephrectomy. The removal of a minor calyx alone was insufficient to prevent recurrence (Hamilton Stewart, 1952, 1953, 1955).

Site of election of stone formation in the kidney

Table I gives the position of the primary calculi in the kidney. Stones were passed or were removed from the same urinary tract prior to partial nephrectomy in 26.9 per cent of the cases in Table I. Five of these cases formed recurrent stones after partial nephrectomy.

TABLE I
POSITION OF PRIMARY CALCULI IN THE KIDNEY

Position	Number of partial nephrectomies	Percentage
Lower pole	111	73
Upper pole	29	19
Upper and lower poles	5	3.2
Upper pole and middle calyx	1	0.6
Lower pole and middle calyx	6	3.9
Total	152*	

* Performed on 144 patients

Eight patients had stones in the lower pole of the kidney; and
of these, 5 were in the lower pole and 3 in the middle calyx.
Sex: male = 50, female = 56.

TABLE II
RECURRENCE OF STONE FOLLOWING PARTIAL NEPHRECTOMY

Period of follow-up (years)	Number of partial nephrectomies	Recurrences	Site of recurrence
16	1		
15	1		
14	1		
13	1		
12	4	1	Lower pole
11	9	2	Lower pole
10	9		
9	3		
8	9	1	Upper pole*
7	6	1	Lower pole
6	9		
5	13	3	Lower pole
4†	13	2	Lower pole
3	15	1	Lower pole
2	12		
1	16		
Less than 12 months	17		
Total	139‡	11	

Recurrence rate was 7.9 per cent

* A recurrence was not noted in the follow-up of 1952

† One case died from acute leukaemia and *post mortem* showed no recurrence.

‡ For various reasons, for example, death from other causes, it was possible to follow-up only 139 out of the 152 partial nephrectomies

The following deductions can be made from the figures shown in Tables I and II. The majority of calculi form in the lower pole of a kidney—73 per cent in the lower pole alone. If several segments are stone-forming, then in over 80 per cent of these kidneys stones will be found in the lower pole as well as in other parts.

If the lowest minor calyx of a kidney alone is removed for stone then there is a

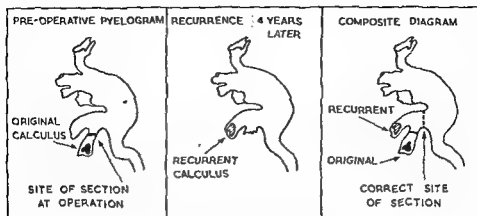


FIG. 132 —Tracings of pyelograms of a case of recurrent calculus after incomplete lower polar partial nephrectomy.

(B) courtesy of the Editor of the British Journal of Urology)

risk that a further stone will form in the other minor calyx (or calyces) of the lower pole which remains. To reduce the risk of recurrence the whole lower pole with its major and minor calyces must be removed, a segmental resection thus being performed.

In the upper pole the risk of recurrence after removal of a minor calyx alone is much less than in the lower pole. If conservation of renal tissue is absolutely essential, then an incomplete upper polar partial nephrectomy (calycectomy) is justifiable.

Segmental resection

A possible explanation of the fact that the whole lower pole must be removed (segmental resection) if recurrence of primary stone is to be avoided, may be found in the anatomy of the lymphatic drainage system of the kidney (Kaiserling and Soostmeyer, 1939; Pierce, 1944, Rawson, 1949; Babics, 1951; and Lowgren, 1955). Connecting lymphatics from the renal cortex and the medulla join in the cortico-medullary zone into larger lymphatics, into which vessels drain from the pyramids. These larger lymphatic trunks travel along with the interlobar vessels towards the sinus renalis. Lymphatic trunks from the pelvis and the proximal ureter also enter the sinus. The lymph from these lymphatics is drained away by four to eight larger lymphatic trunks which leave the kidney through the hilum taking their course along the main branches of the renal vessels to the lymphatic glands.

Graves (1954) has recently shown that the arterial supply of the whole lower pole comes from a single branch of the renal artery. It is therefore likely that the whole lower pole is drained by a single lymph trunk and skiagrams taken after pyelolymphatic backflow tend to confirm this view (Fig. 133). Defective drainage in this lymphatic trunk would therefore impede the drainage of lymph from the whole lower pole. Thus, if Carr's theory is correct, concretions would collect in the lymphatic pathways of the whole pole and stones would be liable to form in all the minor calyces.

When skiagrams are taken of the exposed kidney, and stones are present in the lowest minor calyx, calcium concretions can often be seen related to other minor calyces in this pole. This explains why the surgeon should remove the whole lower pole and not just the stone-containing minor calyx. The recurrences in the series described confirm that this is necessary. It also explains why simple removal of the stone is so frequently followed by recurrence. In the upper pole, Graves has shown that the arterial supply is from several vessels and we have evidence that each of the superior minor calyces has its own lymph vessel (Fig. 134). It is therefore permissible to do a simple removal of a stone-bearing minor calyx in the upper pole without



(a)



(b)

FIG 133—(a) Pyelogram and (b) tracing to show lymphatic vessel draining lower pole.

(By courtesy of the Editor of the British Journal of Urology)

much risk of recurrence. The author had only one recurrence from this procedure in this pole.

Factors which encourage the retention of small calculi in a terminal calyx

Gravity.—The figures have shown that at least 73 per cent of stones mature in the lowest minor calyx. The primary calculus may thus originate in the lower pole and mature there—no doubt the commonest explanation—but on the other hand it may form elsewhere in the kidney and drop by gravity into one of the calyces of the lower pole where it matures.

Adhesion.—Adhesion of the primary calculus to a Randall's plaque would be one explanation of the fact that a calculus can remain in a top minor calyx where it matures, or a part of a stone may be impacted in a Carr's pouch.

Anatomical considerations—A narrow and elongated neck of a calyx due to a congenital abnormality, pressure from tumours and cysts, or fibrosis from previous inflammation would impede the expulsion of a small calculus into the pelvis. A dysfunction of the calyceine musculature due to a neuromuscular defect would have the same result.

Infection.—Infection may well interfere with the normal contraction of the calyceine musculature, producing a type of ileus as in the intestine, and may favour stasis and retention of the calculi.

A classification of renal stone

Primary—(1) Randall's stones formed on calcified plaques on the papillae—these probably also originate as a result of lymphatic obstruction; and (2) Carr's stones with one or more nuclei. These nuclei are calcium concretions which collect in fornical pouches and may form one large stone or multiple small ones.

The origin of both these types of stones is in the renal tissue. They form on a segmental, or in the upper pole, possibly on a partial segmental basis. If a metabolic



(a)



(b)

FIG 134—(a) Pyelogram
(b) tracing to show
lymphatic vessels
pole.

(By courtesy of the Editor of the
Journal of Urology)

disease is present, then usually all segments are involved and the disease may be bilateral.

Secondary stones originate initially in the pelvi-calyceal system and are associated with infection, stasis, recumbency, vitamin deficiency, etc.

Treatment of primary renal stone

It is evident that the presence of a primary stone in the kidney is a sign of a disease and removal of the calculus alone may therefore be insufficient to cure the patient and prevent recurrence. In a small percentage of cases the stone may be one of metabolism or of the renal tubules themselves, and in these cases surgical treatment may be necessary to deal with emergencies. The surgeon should be directed to a cure of the general disorders.

As a rule, however, the primary lesion is in the kidney itself.

Treatment of uretero-pelvic calculi

Whether uretero-pelvic stones have been passed spontaneously, every effort should be made to discover from the origin in the kidney. When operating on stones impacted in the pelvis, even if the clinical radiographs have not indicated

be possible to obtain further evidence at the time of the removal of the stones, by skiagrams of the kidney exposed at operation. These skiagrams frequently show changes not apparent in the clinical radiographs.

Although the various skiagrams according to present day standards sometimes fail to show pathological changes, the following facts may be observed. (1) *Residual calculus in a calyx*; (2) *concretions in a "pouch" or a Randall's plaque*. Rarely, the following changes are seen. (3) *Hydrocalycosis* affecting an isolated calyx or calyces; (4) *fine radial calcification* located to a pyramid.

Only when definite evidence of local pathological changes in the kidney is found, should a partial nephrectomy be performed.

Table III gives the number of uretero-pelvic stones and the site of origin in the author's series.

TABLE III
REMOVAL OF URETERO-PELVIC CALCULI (41)
AND SIMULTANEOUS PARTIAL NEPHRECTOMY

<i>Position of calculi</i>	<i>Lower pole</i>	<i>Upper pole</i>
Pelvis (25)	21	4
Pelvis and ureter (3)	3	
Ureter (13)	12	1

It is thus probable that 87.8 per cent (36 out of 41) of these uretero-pelvic calculi matured in the calyces of the lower pole.

There are cases, however, of uretero-pelvic calculi in which skiagrams fail to reveal any pathology and the stone is then merely removed by *pyelolithotomy* or *nephrolithotomy* if it does not pass spontaneously.

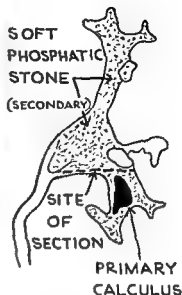
Primary stones associated with secondary stones and their treatment

Secondary stones usually develop in the pelvi-calyceal system as a result of infection, stasis and obstruction. Such an obstruction may be caused by a *primary calculus* impacted in the pelvis or ureter. Moreover, a primary calculus which remains in the pelvi-calyceal system, even though it is not causing obstruction, may be responsible for persistence of infection. Its presence prevents sterilization of the urinary tract. *Secondary phosphatic stones* may develop especially if the infecting organism is a *urea-splitter*. On the other hand the *primary stone* may rapidly increase in size because of deposition of phosphatic layers, and thus it may have the outward

may reveal the presence of a primary calculus and secondary calculi: they have been superimposed as a result of infection. Skiagrams of the exposed kidney may reveal changes in a segment of the kidney which indicate that it is pathological and stone-forming.

In these cases, a *partial nephrectomy* should be performed and the stone-forming segment excised. Any stones which remain should then be removed through the opening in the pelvi-calyceal system and all debris washed out. The kidney must not be closed until skiagrams have shown it to be free from calcareous material (Figs. 135 and 136).

If the kidney is markedly *hydronephrotic* from obstruction due to stones, then the removal of the lower pole of the kidney, if this is the pathological and stone-forming segment, will result in a reduction in the capacity of the kidney and an improved function. Hjort of Oslo (1953) has made a similar observation and treats a large *hydronephrosis* by partial resection of the elongated kidney and maintains that the dynamic efficiency is improved.



BEFORE OPERATION

FIG 135.—*Left* Pyelogram, *right* tracing to show solitary functioning kidney containing primary calculus in the lower pole and secondary phosphatic stones in the pelvi-calyceal system—infection Urea splitter—*B. proteus*. Lower polar partial nephrectomy and removal of secondary stones through the partial nephrectomy incision. Pedicle clamp compression four and a half minutes

(By courtesy of the Editor of Brit J Urol)



AFTER
OPERATION

FIG 136.—*Left* Pyelogram, *right* tracing to show the state of the same kidney (Fig. 135) after operation. Urine sterile. Blood urea 22 milligrams per 100 millilitres.

(By courtesy of the Editor of Brit J Urol)

Recurrence of stone and its prevention

Recurrence of stone following operations may be (1) true—when an entirely new stone follows the complete removal of the original stone or stones; or (2) false—when a fragment or fragments of the original stone remains and further deposition of calcium occurs. For the purpose of comparison of results in the conservative renal operations, all recurrences, whether true or false, must be included.

It is difficult to obtain from the literature an accurate idea about the incidence of recurrence after partial nephrectomy. The number of cases recorded in any given series is often small and the length of time of the follow-up is seldom stated. It is clear from the figures previously shown that unless skiagrams are taken the recorded incidence of recurrence is of little value. Moreover, a recurrence may not be seen, say, 5 years after an operation and yet may be found after 10 years. The nature of the pathogenesis of stone makes it likely that recurrence of primary stone may be long delayed. In the author's series the recurrence rate was 7.9 per cent for infected and non-infected cases observed by radiographic examination over a period of up to 16 years. This percentage is capable of considerable reduction now that more knowledge on the subject has been obtained.

Causes.—(1) Failure to remove completely a stone-forming segment, or segments, of the kidney. The whole lower pole must be removed. In the upper pole a calycectomy is permissible if it is essential to conserve renal tissue.

(2) Fragments of calculi left behind in the pelvi-calyceal system. Skiagrams must be taken of the portion of kidney removed to prove that it contains all the stones for which the operation was performed. A skiagram must also be taken of the kidney tissue remaining as a check to ensure that no further stones or fragments are present.

(3) Blood clot allowed to remain in the pelvi-calyceal system may act as a nidus for the deposition of further stones and, moreover, may encourage infection. It invites pelvic obstruction, distension and extravasation of urine.

(4) Persistence or introduction of infection. Drainage of the renal pelvis after partial nephrectomy is rarely, if ever, necessary. It encourages the introduction of infection into the kidney which may jeopardize the result of the operation. No patient with stone can be considered cured until infection has been completely eradicated. This should be accomplished before the patient is discharged from hospital.

(5) Faulty closure of the pelvi-calyceal system resulting in narrowing of a calyceal neck or the pelvi-ureteric junction with resulting stasis.

(6) Faulty position of the kidney after replacement. The kidney should be retained in a high position in the renal bed by nephropexy. Slight rotation of the kidney is thus obtained by this procedure so that drainage from the calyces is encouraged and kinking of the ureter obviated.

(7) Other factors. Obstruction and infection in other parts of the urinary tract should as a rule be eradicated before a partial nephrectomy is performed. General metabolic diseases such as hyperparathyroidism, cystinuria, vitamin A deficiency, and the like must also be corrected.

Partial nephrectomy in preference to pyelolithotomy and nephrolithotomy in the treatment of localized calculi

In the older conservative operations of pyelolithotomy and nephrolithotomy, no attempt is made as a rule, to correct any underlying factors which may, in part, be responsible for the formation of calculi—the stones are merely removed. After these procedures, the probability that further stones will form is considerable, as nothing has been done to try to prevent their formation. The usual recurrence rate of 15–45 per cent of a

the primary cause.

Renal tuberculosis

Hippocratic aphorism—be prepared to do the right thing at the right time, in which patient, attendants and external circumstances must co-operate

The results of surgical treatment in the past have been poor. The cases tended to develop urinary fistulae and wound infection, and haemorrhage and persistence of urinary infection usually made a subsequent nephrectomy necessary. Nephrectomy was thus considered the procedure of choice in unilateral renal tuberculosis without regard to the pathological anatomy.

In recent years, the trend of surgery has been towards conservative treatment by partial resection. The principal reasons for this change in outlook are as follows.

(1) The advent of anti-tuberculous drugs, for example, streptomycin, PAS (para-aminosalicylic acid) and isonicotinic acid hydrazide, and a knowledge of their use in pre-operative and post-operative treatment.

(2) Improved radiographic methods—aortography and renal angiography and improved intravenous urograms

(3) A better understanding of the basic principles involved in the selection of cases and the performance of the operation of partial nephrectomy.

(4) The realization that, contrary to the teaching of Albarran, tuberculous lesions of the kidney can heal spontaneously (Medlar and his colleagues, 1929)

The advantages of partial nephrectomy over nephrectomy

Advantages of partial nephrectomy are:—(1) conservation of renal tissue; (2) bilateral surgical treatment becomes possible; and (3) a local destructive lesion in a solitary kidney may be removed.

Semb (1949) was largely responsible for rekindling our interest in this subject. He considered that it was useful to draw a parallel between renal and pulmonary tuberculosis. As the surgical treatment of pulmonary tuberculosis had, in his opinion, given good results, he felt that the possibility of applying the same principles in the treatment of both pulmonary and renal tuberculosis should be examined. He divided his cases into three groups, in all of which medical treatment was essential.

Group 1.—Infiltration without macroscopic destruction, the so-called "parenchymatous" form—medical treatment only

Group 2—Local destruction with cavity formation—excision of this portion of the kidney by partial nephrectomy. The patient's own powers of healing together with modern medical treatment are relied upon to destroy any other areas of infiltration in the renal parenchyma, or the secondary spread to the renal pelvis, ureter and bladder. Semb considers that there is less chance of the spontaneous healing of a macroscopic cavity in the kidney than in the lung and, in practice, one can assume that healing will not occur

Group 3—Total destruction—nephrectomy.

Choice of case for partial nephrectomy

General principles—It must be realized that patients suffering from genito-urinary tuberculosis have suffered or still suffer from general tuberculosis. All cases should therefore be given a course of medical treatment including the use of anti-tuberculous drugs prior to operation. If active lesions are present in extra-urogenital organs then these lesions should be treated in the first instance, as the operation on the kidney might re-activate the disease.

An exception may be made to this rule, however, when it is considered that an acute lesion of part of the urogenital system is causing such a toxæmia that improvement in the patient's general health is not possible without its eradication. A secondarily infected tuberculous pyonephrosis or tuberculous epididymo-orchitis would come into this category.

The location of destructive lesions in the kidney

Destructive lesions are most common in the upper pole, whereas in stone formation, the lower pole is most frequently involved. The statistics in Table IV are of interest.

TABLE IV*

Position	Destructive tuberculous lesions (Carl Semb)	Renal calculi—stone forming segments (Hamilton Stewart)
	Per cent	Per cent
Upper pole only	66 (42)	21 (29)
Central division only	20 (13)	0 (0)
Lower pole only	14 (9)	79 (111)

* Kidneys in which more than one division or segment were diseased are not included in Table IV, hence the rise in percentage compared to Table III

An explanation of these facts probably lies in the suggested aetiology of the two conditions. The author would not like to offer a definite explanation of the peculiar difference in the localization of these two forms of renal disease. Certain differences in their causation may be pointed out. Tuberculous foci are considered to be blood borne. The upper pole is supplied by three groups of arteries (Graves, 1954)—apical and upper segmental arteries and branches from the posterior segmental artery—whereas the lower pole is supplied entirely by the one vessel—the lower segmental artery. As the upper pole is supplied by a larger number of arteries than the lower or intermediate portion of the kidney, then it could be expected that destructive tuberculous lesions would be more common in the upper pole.

Stone formation would not appear to have any relationship to arterial renal supply but is probably dependent as previously described, on inadequate lymphatic drainage. Gravity may have some influence on the ultimate position of stones, but not on the localization of tuberculosis.

Investigation of a case to determine suitability for partial nephrectomy

An accurate history is taken and a search made for evidence of any dormant or active extra-urogenital lesions.

A full urological investigation is carried out, which will not be referred to in detail. The intravenous pyelograms should be of first-rate quality. Repetition of the examination may be necessary before the desired standard of pictures is obtained. Ureteric compression is essential. Ureteric specimens should be obtained from each kidney for urea estimation, cytological examination and microscopical and cultural examination for tubercle bacilli. Ascending pyelograms should be obtained only if the intravenous pyelograms fail to furnish the required information. There is always the danger of dissemination of the disease by pyelovenous or pyelolymphatic backflow, and the possibility of introducing infection. The cystoscopic examination will enable the surgeon to portray in diagrams the site of tuberculous lesions, so important in future follow-up of the case.

If the pyelograms show that at least one-third of a kidney is functioning satisfactorily and the calyces are normal, then aortography and renal angiography should be delayed until the patient has received medical treatment for 4–6 weeks. Extensive destructive lesions involving all divisions of the kidney rule out the case for conservative surgery. There are cases, however, in which doubt exists and aortography and renal angiograms may be advisable at this early date.

The pyelograms demonstrate the presence of cavities communicating with the pelvi-calyceal system and renal angiography is relied upon to show closed destructive lesions, a relative absence of vessels being noted in the affected areas.

The main problem is to ensure that destructive cortical lesions are not missed.

PART II—CRITICAL SURVEYS



FIG. 138 —Angiogram of solitary left kidney. Demonstrating destructive lesion in centre of kidney. *N.B.*—The vessels to the central portion stop abruptly before reaching the cortex. The central portion is thus avascular. These findings indicated a destructive lesion



FIG. 139 —Photograph of the median portion of the solitary kidney showing tuberculous abscess

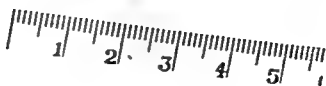


FIG 140.—Intravenous pyelogram eighteen months after operation (Compression used) Urine free from pus cells and tubercle bacilli



FIG 141.—Intravenous pyelogram eighteen months after operation (no compression).

PART II—CRITICAL SURVEYS

Examination of the kidney at operation may reveal no evidence of their existence. If there is still doubt, a renal angiogram should be obtained on the exposed kidney. the angiographic medium being injected into the aorta just proximal to the renal artery in preference to injection into the renal artery itself. The long needle used in the former procedure does not interfere with the positioning of x-ray films or the cone of the x-ray apparatus.

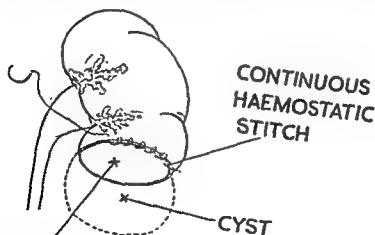
The management of a case considered suitable for partial nephrectomy.

In the majority of cases which are presented to the urologist for treatment, any extra-urogenital lesions are quiescent or have been cured. I shall therefore consider the treatment of these cases only.

Pre-operative medical treatment.—A period of about 6 weeks should be spent, preferably in a sanatorium. During this time, the case will receive treatment with anti-tuberculous drugs. The important principle in treatment is to combat acute lesions and to improve the patient's general health, and yet to avoid making the organism drug resistant. It is essential that the anti-tuberculous drugs shall give cover during the operation and in the post-operative period, and will thus prevent infection not only in the wound in the kidney, but also in the parietal incision. Although the basic principles in the medical treatment are the same in the various sanatoria, the regime varies slightly.

Research has shown that in the use of the anti-tuberculous drugs, if two are given together the risk that the tubercle bacillus will become insensitive is reduced. Two (or three) of these drugs are thus always given together for varying periods of time and then the combination is changed.

The case is reviewed again at the end of this period of medical treatment. The urine is examined for tubercle bacilli, intravenous pyelograms are obtained, and also renal angiograms. Rarely, ascending pyelograms will be required, but if so, the operation should not be performed until 14 days have elapsed after the examination in order to allow any reaction to subside. As I have already mentioned, certain cases originally considered suitable for conservative surgery may now prove unsuitable, and nephrectomy may be the only possible course.



**FATTY TISSUE SUTURED
INTO CAVITY FOR
OBLITERATION**

FIG. 142.—Method of treating solitary cyst of kidney.

The night before the operation, the patient is given all three of the anti-tuberculous drugs in full dosage. Streptomycin 1 gramme is given immediately prior to the operation, and thereafter the three anti-tuberculous drugs are administered for a period of 14 days. Subsequently, the standard medical treatment is given for a period of 1 year.

If the post-operative functioning tissue is only a part of one kidney, care must be taken to avoid the intake of excessive fluids with the associated danger of oedema.



FIG 143—Specimen removed by partial nephrectomy—massive hydrocalycosis due to obstruction by a calculus impacted in a major calyx. Two cavities representing the minor calyces

Solitary cyst and localized hydrocalyx

A solitary cyst can occasionally be dissected out with ease and with little bleeding. It is usually advisable, however, to excise the major portion of the cyst wall and control haemorrhage by a running stitch. The cavity lined by the remaining portion of the cyst wall, is then obliterated by

A hydrocalyx must be distinguished underlying pathology, for example, growth, stone, and the like, must be sought for. If conservative surgery is decided upon, a partial nephrectomy should be performed through healthy parenchyma. Failure to do this may result in a recurrence of the condition, or a fistula (Fig. 143)

Hydatid cysts may occur in the kidney.

Removal of infarcted and severely lacerated portion of kidney

In the operation for hydronephrosis due to ureteric or uretero-pelvic obstruction by a lower polar artery, certain urologists advise that after division of the obstructing vessel the infarcted area of the kidney should be removed to prevent subsequent complications. This was the method of treatment adopted by the author in preference

PART II—CRITICAL SURVEYS

to uretero-pelvic anastomosis in front of the obstructing vessel until he devised his nephroplasty operation (Hamilton Stewart, 1947). This latter operation enables the obstruction to be removed without interfering with the renal blood supply or the uretero-pelvic continuity. The question of infarction need no longer enter into the treatment of hydronephrosis due to a lower polar artery.

In those cases in which surgical intervention is decided upon for the treatment of lacerations of the kidney as a result of injury, it is probable that in the past many kidneys have been unnecessarily removed. It is possible to conserve portions of kidney which will function normally, and it must be remembered that one-third to one-half of a kidney can sustain life. Renal tissue should be removed only when it has been severed from its blood supply or the pelvi-calyceal system.

Tumours

Partial nephrectomy will not often be the method of choice in the treatment of tumours of the kidney. If the surgeon can be sure, and this must rarely be so, that he is dealing with a benign tumour, then the method is ideally suitable. Possibly it has a place in the treatment of certain malignant tumours arising in a solitary kidney, but radiotherapy may be considered an alternative method of treatment.

GENERAL PRINCIPLES IN THE OPERATION OF PARTIAL NEPHRECTOMY

How much renal tissue is necessary to sustain life?
A man can live in good health and have a normal blood urea provided he possesses one-third to one-half of one kidney. The remaining kidney tissue must, however, be normal.

An intravenous pyclogram obtained 18 months after removal of the lower half to two-thirds of the organ for tuberculous disease is shown (Fig. 144). The other kidney had been previously removed for the same disease. The urea concentration test is as follows:

Blood urea: 42 milligrams per 100 millilitres
Urea concentration test (15 grammes of urea in 100 millilitres of water. No fluid for 8 hours):

After urea hours	millilitres	per cent	Urea grammes
1	90	1.81	1.63
2	100	1.94	1.94
3	60	2.25	1.35

Urine: pus—nil No tubercle bacilli.

Control of Infection

When the operation has to be performed in an infected case, it must be done under cover of antibiotic (and sulphonamide) treatment if possible. The surgeon may feel it wise to use more than one antibiotic. As the chances of sterilization of the urine in the presence of stones is unlikely, and as there is a real danger that the organism may rapidly become insensitive, the ideal time for the sterilization of the urine is immediately after the stones have been removed. A maximum blood concentration of the antibiotic (and sulphonamide) should therefore be present at this time. In the case of streptomycin the initial dose should be a large one (1 gramme) given 4 hours before the operation. At the termination of the operation a further 1 gramme should be given, and thereafter 0.5 gramme 6-hourly until 8-9 grammes in all have been received by the patient. Garrod (1951) has stated that in the case of *Bacterium aerogenes*, resistance may develop within 24 hours, and if treatment should fail there may be no second chance as resistance to streptomycin is permanent.

On occasions in the author's cases, a positive culture of an organism has been obtained from the surface of a calculus or from a calyx when no growth was obtained from the patient's urine before operation. If this should prove to be the case, then the appropriate antibiotic must be given immediately this fact is known and a full course administered.

The prevention of a tuberculous infection in the renal wound and in the incision in the abdominal wall has been considered under the special heading. In the relatively small number of operations for renal tuberculosis carried out by the author, there has been no single case in which a tuberculous infection of kidney or parietes has occurred, nor any fistula.

Operation for bilateral disease

As a general rule, when it has been decided that a partial nephrectomy should be performed on both kidneys, the better kidney should be operated upon in the first instance so that this kidney may be functioning satisfactorily at the time of the second operation. It may prove inadvisable to retain the second kidney which may prove to be more diseased than was realized. As the surgeon is aware of the condition of the first kidney, he will be able to decide whether a nephrectomy is feasible.

Incision, exposure and mobilization of the kidney

The majority of surgeons use an incision through the bed of the twelfth rib. The incision can, if necessary, be enlarged anteriorly without injury to nerves. It is wise, as Lane (1950) suggested, to depress the kidney bridge during the period of excision of the rib, thus reducing the danger of injury to the pleura. Any of the recognized incisions may be used however. Great care is taken in the delivery of the kidney into



FIG. 144 —Intravenous pyelogram (20 minutes) after removal of one-half to two-thirds of a solitary kidney for tuberculous disease

the wound and squeezing or compression avoided so that the position of the stones in the kidney is not disturbed or tuberculous material expressed into the venous system. The under-surface of the pelvis and pelvi-ureteric junction are displayed with the minimum amount of dissection and interference with the surrounding connective tissue with its contained lymphatics.



FIG. 145—Straight x-ray (left) and pyelogram (right) of exposed kidney taken at operation. The operation was performed for the cluster of stones in the middle calyx. The presence of the small calcific body in relation to a minor calyx of the lower pole was discovered on x-ray of the exposed kidney. The middle third of the kidney (with its contained stones) and also the lower pole were removed.

(By courtesy of the Editor of the British Journal of Urology.)

X-ray examination of the exposed kidney

In all operations for stone in the kidney, the final assessments of the case can only be made after study of high quality radiographs obtained of the exposed kidney (Fig. 145). Small calcific bodies may be present though not visible on the pre-operative clinical radiographs. At least two radiographs should be obtained in order to rule out the possibility of artefacts. After the kidney has been mobilized a sling of sterile gauze is slit as in Fig. 146 and is passed around the kidney. The slit allows the sling to encircle the pedicle and the kidney is gently lifted as far out of the wound as possible. If preferred a strand of nylon may be placed under each pole and grasped together above the kidney with a pair of artery forceps. The kidney is thus supported rather like a hammock. This latter procedure reduces the risk of marks on the skiagrams, but is less secure. The outer edge of the wound is firmly depressed by the sterile cone attached to the x-ray tube (Fig. 147). The following is abridged from Dr. Carr's description of technique:

"It is essential to use a special cone with a rectangular end and this end is closed by a sterile linen diaphragm stretched tightly across the opening. The kidney is then gently but firmly pressed against the diaphragm so that it is completely immobilized

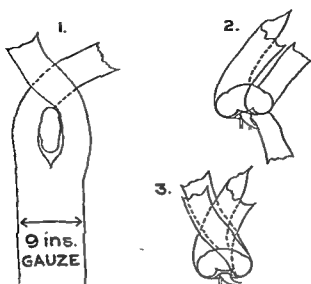


FIG 146.—A method of applying gauze sling.
(By courtesy of the Editor of the British Journal of Urology)

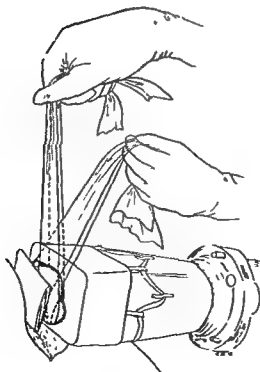


FIG 147.—A method of x-raying the kidney.
(By courtesy of the Editor of the British Journal of Urology)

whilst the picture is being taken. The film is inserted into the wound behind the kidney and in contact with it. The most suitable film is non-screen Ilford Standard Speed which is specially packed for the purpose, 12×9 centimetres, in paper envelopes. These are sterilized in the ordinary formalin sterilizer and when they are to be used they are put in special bags of thin rubber which are also sterilized and used once only. The x-ray machine has a high output rotating anode tube with a fine focus so that the exposures are kept to the minimum. The films are developed in special developer for 30 seconds and are available for inspection in a minute and a half. Further details of the technique are available in the published account (Carr, 1955).

Pyelograms of the exposed kidney may be necessary to determine the exact relationship of calcified bodies to the pelvi-calyceal system. A small Crile's clamp is placed on the ureter and 10 millilitres of Pyelctan, diluted 1 : 4, are injected through the finest hypodermic needle passed obliquely into the renal pelvis. Skiagrams may reveal inadequate filling and if so a further injection is made. Skiagrams must be taken in pairs for the reason already mentioned.

When operating upon a tuberculous kidney a straight skiagram should be taken in all cases as it may reveal a caseous lesion. If the angiograms taken prior to the operation are not of the desired quality, then they may be repeated on the kidney when exposed. The author prefers the injection to be made into the aorta directly proximal to the renal artery. The needle is passed in the usual way below the left twelfth rib and the point of the needle can be directed by a hand inside the wound so that it is in direct contact with the aorta. The kidney is then delivered as described, the cassette placed in position and the injections made at the desired time. In this way the needle does not pass through the wound and does not interfere with the placing of the cassette or the x-ray tube. When the left kidney is operated upon the patient can be placed in the usual kidney position, but when an angiogram of the right kidney is required, the patient is placed in the prone position. This variation is necessary in view of the position of the aorta.

Haemostasis

Ligation of the vessels in the hilum

The kidney is a segmental structure and it is thus possible to remove one or more segments without damage to the remaining part. It must be remembered, however, that the arteries are end arteries and proximal ligation of any vessel at the hilum may result in infarction of renal tissue of greater or lesser extent than the segment or segments to be removed. In order to avoid this danger, surgeons advise a thorough exposure of the renal pedicle in order to observe the artery and vein which appear to supply the portion of kidney to be removed. Temporary occlusion of these vessels may result in discoloration of the area of blood supply. After injection of contrast medium the author found that it corresponded exactly to the desired plane of section. If necessary it is necessary to ligate or control by "figure-of-eight" stitches, the vessels in the renal wound and not by proximal ligation at the hilum. Even an accessory or lower polar artery should not be ligated proximally unless it is actually "attached" to the portion of renal tissue which is to be removed. The parenchymal or pedicle clamp is released from the main vessels.

Up to the renal pedicle, makes his incision near the hilar border, and opens out the wound with forceps. Those vessels passing to the portion to be removed are then ligated. In this way, the risk of dividing vessels passing to the kidney tissue to be retained is reduced. The procedure, however, necessitates the use of a pedicle clamp for a long period with resulting danger of prolonged renal ischaemia. This is par-

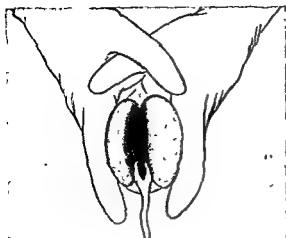


FIG 148 —The index fingers of the assistant used as a haemostatic clamp

ticularly undesirable when the operation is performed on a solitary kidney, which is often the case

Control of haemorrhage during section of the kidney

Control of haemorrhage is important not only for the general well-being of the patient, but in order to facilitate an accurate examination of the pelvi-calyceal system after section of the kidney. The safest method is by the use of parenchymal compression near the site of section. Ischaemia of only a small portion of the kidney thus results. The index fingers of the assistant's hands clasped as illustrated in Fig 148 is efficient. This method is apt to be tiring to the assistant, who at times must have staying power. The author's rubber covered parenchymal clamp which has adjustable blades (Fig. 149) is also satisfactory. When this method of control does not permit the surgeon to obtain the necessary knowledge of the pelvi-calyceal anatomy then temporary compression of the renal pedicle is used, either by digital compression by an assistant, a tourniquet of rubber tubing, rubber bands or tape, or by a rubber-shod pedicle clamp as devised by Cráfoord Van Slyke and his colleagues (1944) have stated from experimental evidence on dogs that it is possible to clamp the renal pedicle for as long as 3 hours without causing permanent damage to renal function. The blood urea nitrogen concentration rose, however, in the first 2 or 3 days to over



Fig 149 —Parenchymatous clamp. The angle of the blades can be altered and fixed by the ratchet fitting
(Made By Messrs. Thackras & Leeds)

150 milligrams per 100 millilitres but by the fourth day, before retention became fatal, the clearance of urea began to improve and the concentration of blood urea to fall. It ultimately returned to normal values over the course of the next 2 to 3 weeks. Compression of the renal pedicle thus causes depression of the renal function, the degree depending on the length of time the clamp is used at any one period. If the operation is performed on a solitary kidney and when it is realized that a portion of this kidney is to be removed, even a temporary interference in the function may be a serious matter.* Prolonged compression would result in permanent damage to the kidney and the risk of thrombosis. The author dislikes its use for more than 5 minutes. It is then released and haemorrhage controlled for one to 2 minutes by digital compression of the kidney. Compression may then be re-applied. Several such changes in the control of haemorrhage may be necessary but the aim should be to use the

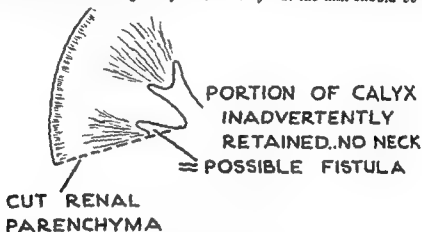


FIG 150.—Danger of retaining a damaged calyx.
(By courtesy of the Editor of the *British Journal of Urology*)

pedicle clamp for as short a period as possible. During compression of the renal wound, blood may collect in the pelvi-caecal system and it is essential to ensure that all clot is removed at the end of the operation.

Certain details in the surgery of the kidney

When operating upon the kidney, the surgeon must constantly have in mind the fact that the arteries to the kidney are end arteries and injury of a main vessel will result in a large infarct. Serious complications may follow, particularly if the urine is infected.

So far as the pelvi-calycal system is concerned, it is essential that after operations on the kidney, each calyx shall possess a neck of sufficient calibre to drain away the urine. If not, hydrocalycosis, persistent infection, and the like, may occur. It is even more essential that a calyx or portion of a calyx with its papilla should not be left without a channel for drainage (Fig. 150). Such an oversight is likely to cause a permanent fistula. If a calyx and its neck are damaged and cannot be accurately reconstructed, it is preferable to excise them completely.

Partial nephrectomy incisions

The incisions that can be used are. (1) straight section; (2) wedge section; (3) decapsulation of portion of kidney to be removed, followed by section of kidney; (4) prolongation of the incision into the pelvis; or (5) prolongation of the incision into the cortex (nephrolithotomy)

The section can be made with a scalpel or diathermy. The latter method may cause deep necrosis and is not advised. The author uses the wedge resection in the plane previously depicted (Fig. 125a, p. 190) and the capsule is cut at the line of the incision

* Refrigeration of the kidney may be helpful, but sufficient experience has not yet been obtained.

The flaps should be $\frac{1}{2}$ inch in length. This incision facilitates closure of the renal wound and the flaps when brought together tend to control oozing from the cut surfaces. These flaps must not be subjected to trauma.

Calculi are often present in the pelvis of the kidney or upper ureter in addition to those in the kidney. These pelvic or ureteric stones can be removed at the start of the operation by pyelolithotomy or ureterotomy. If the lower pole, however, is the stone-forming segment, as is usually the case, it is often possible, with forceps, to extract the stone through the divided major calyx. If necessary, however, an incision in this calyx can with ease be prolonged into the pelvis (Fig. 125a). A staghorn calculus arising in the lower pole may be extracted in the same way. Occasionally the partial nephrectomy incision has to be enlarged and a nephrolithotomy performed. In the extraction of stones from the pelvis and other calyces, great care must be taken to avoid trauma. This is one of the commonest causes of primary intra-pelvi-calyceal haemorrhage.

Line of section of the kidney

Two viewing boxes at eye level and on the same support should be placed near the surgeon. On the one is placed a clinical pyelogram and on the other a protected

The aim of the surgeon should be to retain functioning renal tissue which is free from stone and calcific bodies which have a direct relationship to the fornices of the calyces. The author has already described that these bodies are often to be seen in the stone-forming pathological segments and they are removed in the resected renal tissue along with the stone.

Rarely, however, stones may be present in one segment of the kidney and yet calcific deposits may be observed in another segment also (Fig. 145, p. 214). If pyelograms show that these deposits are in direct relationship with the fornix of a calyx and are in fact concretions as defined by Carr, then this segment must also be removed in addition to the segment containing the stone.

If, however, skiagrams of the exposed kidney show calcified bodies throughout the kidney in addition to the stone for which the operation is being performed, then it is clear that partial nephrectomy cannot be a curative operation. In these cases the stone should be removed and the kidney tissue left undisturbed, or the segment in which the stone lies should be resected. It should be realized that these procedures should not prove curative but the patient may probably remain free from trouble for many years. It is possible that such a case is one of a disordered calcium metabolism.

The excision should preferably be by wedge resection as described and the apex should lie along a line which can be determined as follows:

Resection of the lower pole

(a) The line extends across the kidney from the top of the convex lower border of the pelvis. This line usually passes at right angles to the long axis of the central portion of the kidney but may vary slightly according to the calyceal anatomy. The aim should be to cut through the lowest major calyx as it joins with the pelvis (Fig. 151)

(b) The pyelogram taken of the exposed kidney is examined and the line of section determined. The distance of this line from the lower edge of the kidney is measured by a large caliper which is not allowed to touch the film. As little, if any, magnification has occurred in this x-ray the exact line of section can be marked on the exposed kidney.

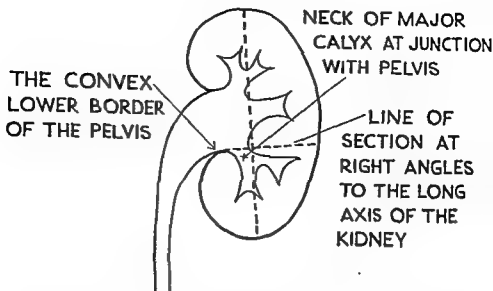


FIG 151 —Line of section

(c) If the calyceal anatomy is abnormal, then after compression of the renal pedicle, the lower pole may be split in the long axis until the pelvis and lowest major calyx are opened. Having determined the correct depth, the renal flaps can then be fashioned.

Resection of the upper pole

Resection of the upper pole is fraught with more danger. The artery to the posterior segment lies close to the superior pelvi-calyceal junction. This fact has also been noted by Graves (1954). It is therefore unwise to attempt to remove the whole of the superior major calyx when operating for stone as there is a danger of injuring the vessel with a resulting infarct of the posterior part of the kidney. Moreover, it is not essential (as in the lower pole) that the whole of the major calyx be removed.

It is also wise when performing a partial nephrectomy for stone to retain a thin lip of the medial or hilar border of the upper pole. In this way, the renal vein which lies in direct relationship to this part of the kidney is protected.

Resection of median portion

In tuberculosis, the disease most commonly affects the upper pole. The middle part, however, may be involved and the poles remain free. In the latter case the lines of section have to be accurately determined by study of the pyelograms and renal angiograms. The calyces which have to be removed are known and the appropriate lines of section marked on the kidney. Following the operation, the kidney tissue which remains is drained by an upper and lower major calyx, and the kidney would thus appear to have a bifid pelvis. A wedge resection is used on each side of the tissue to be removed to facilitate closure of the renal wounds. No attempt is made to approximate the two halves of the kidney, the space being filled with perirenal fat.

Closure of the wound in the kidney

Surgeons differ in their views as to the best method of closing the renal wound. Most are agreed, however, that accurate closure of the pelvi-calyceal system is essential. A running stitch of 0000 plain catgut in a fine needle is used. Although the main vessels have been controlled by ligation or figure-of-eight stitches, some oozing occurs from the cut surface. In order to control this, fat, muscle, fibrin foam, Oxycel, and the like, have been sutured between the flaps and if the capsule has been dissected

free, this is closed firmly over these foreign bodies. Lowsley (1933) uses catgut tape for the approximation of the capsular incision.

The author is of the opinion that foreign bodies encourage infection and that their use is unnecessary. He considers that many of the complications which have followed partial nephrectomy are due to the sloughing of renal tissue primarily as a result of interference with blood supply from faulty suturing. A certain amount of ischaemia and necrosis occurs after every incision in the renal parenchyma. When small peripheral arteries which are end arteries, are severed, the area of ischaemic necrosis is small (1-2 millimetres) but if larger vessels are included in sutures, then the necrosis

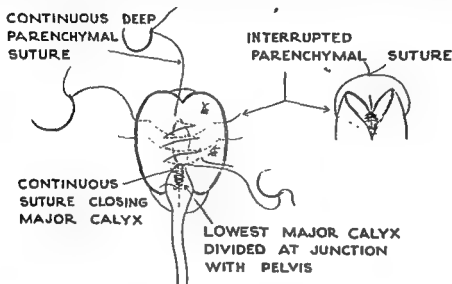


FIG 152—Closure of renal wound
(By courtesy of the Editor of the British Journal of Urology)

will be considerably greater. All sutures, therefore, which cut off or strangle the blood supply are bad. They not only may cause necrosis of portions of renal tissue with risk of infection and secondary haemorrhage, but they may also cause, for the same reason, fistulae. Cobbler stitches, mattress sutures, and the like, are thus to be condemned.

The author performs a cuneiform or wedge partial nephrectomy as shown in Fig 125a. When suturing the renal flaps together, for after all that is what they are, the sutures of 000 plain catgut are not placed nearer together than $\frac{1}{2}$ inch and the same distance from the edge of the wound, and they are lightly tied. From practical experience, this form of suturing does not interfere with the blood supply of the flaps (Fig 152). Then again it is important that any blood which may ooze from the renal flaps shall escape from the renal wound and pass out to the exterior through the renal space drain. It should not be permitted to pocket in the renal wound or escape into the pelvis of the kidney. In order to avoid these complications the renal capsule is not sutured separately, but is merely brought together by the interrupted parenchymal sutures described. Adequate drainage to the exterior between the sutures is thus possible.

Correct position of the kidney after replacement

Gravity would appear to play some part in the maturation of stones in a dependent calyx. Thus after a partial nephrectomy operation, the kidney should be placed at the top of the renal space and retained there by suturing the renal fascia below it.

The fascia thus acts as a sling. A few of these sutures can with advantage be placed through the quadratus lumborum muscle.

This procedure also straightens out the ureter and avoids kinking of the ureter with subsequent obstruction.

Drainage of renal space and vesical drainage

A drain is placed down to the kidney and retained for 5 days, an underwater seal being used if desired. An indwelling urethral catheter is used during the immediate post-operative 12 to 24 hour period so that any haemorrhage into the bladder may be recognized, should it occur, and clot retention prevented by irrigation.

COMPLICATIONS AFTER PARTIAL NEPHRECTOMY

Mortality

This is about the same as after pyelolithotomy—2.58 per cent (Abelhouse and Lerman, 1950). The author had 2 deaths out of 152 operations (1.3 per cent). One patient died from pulmonary embolism and the other from an unrecognized clot retention of the bladder.

Primary haemorrhage

Intrarenal

This usually occurs as a result of trauma to the pelvic lining and particularly to the neck of the calyces by extraction of stones.

Extrarenal

Inadequate haemostasis at the operation is responsible. Although this haemorrhage usually escapes to the exterior through the drainage tube, a haematoma may develop under the flaps and rupture through into the pelvi-calyceal system.

Secondary haemorrhage and urinary fistulae and their causes

These complications are considered together as the author is of the opinion that the same basic causes are usually responsible for both conditions. In the author's cases, secondary haemorrhage occurred only in rare instances, was never sufficiently severe to cause anxiety, and a nephrectomy for this reason was never necessary. Temporary urinary fistulae occurred on two occasions and persisted in one case for 7 days, and in the other for a few days only. It is probable that in one of the cases this complication was due to the division of a lower polar artery and that the infarcted area was more extensive than the tissue removed in the lower polar partial nephrectomy.

Causes.—(1) Interference with the blood supply. This subject has already been discussed.

(2) Extravasation of urine into the renal wound. This complication may result in necrosis of tissue as in extravasation elsewhere, secondary haemorrhage, infection and fistula formation may follow. (a) inadequate closure of the calyceal neck (and pelvis); (b) persisting pelvi-ureteric obstruction, this may be due to a calculus which has been dislodged unknowingly from a calyx or to blood clot, or to an unrecognized co-existing ureteric lesion; and (c) faulty position of the kidney after replacement with resulting kinking of the ureter and obstruction.

(3) Infection has already be considered, but the author would like to stress the inherent danger of the insertion of drainage tubes into the kidney. Drainage of the kidney following partial nephrectomy is inadvisable and very rarely necessary. The drainage tube may cause necrosis of renal tissue with subsequent danger of secondary haemorrhage and fistula formation, and its use encourages the introduction of

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PARALYSIS OF THE LARYNX

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Paralysis of the larynx may be unilateral or bilateral, complete or incomplete, and either of central or peripheral origin.

CENTRAL PARALYSIS

Lesions of the central nervous system giving rise to recurrent nerve paralysis are found in a variety of conditions, the most commonly encountered being *tabes dorsalis*, *glosso-labio-laryngeal paralysis* and *vascular disorders* affecting the bulbar region. Although in such cases the symptoms of laryngeal obstruction tend to be progressive, they develop relatively slowly and the causative disease is often quite advanced before the laryngologist has to be consulted. Paralysis of the pharynx giving rise to difficulty in swallowing are frequently associated, and these may give rise to cough and choking by causing overspill of saliva and fluids into the larynx.

Unless the bulbar palsy is due to syphilis treatment is mainly palliative, but since the laryngeal obstruction is often incomplete, operative treatment to restore the airway is seldom required. When, however, there is dyspnoea giving rise to increasing distress, tracheostomy will relieve and should not be withheld in spite of the eventually unfavourable outlook.

PERIPHERAL PARALYSIS

The recurrent laryngeal nerve is the motor nerve to the intrinsic muscles of the larynx. Owing to the length of its course and anatomical relations in the neck, as well as in the thorax, it is particularly vulnerable to injury and disease.

According to Semon's law, in all lesions of either the centre or trunk of this nerve, those fibres supplying the abductor muscle, the crico-arytenoid posticus, are first involved, whereas the adductors may continue to act for a variable period of time. Except in gross lesions, therefore, when complete paralysis will occur at once, the abductor may be the only muscle affected and recurrent nerve palsy is frequently described as abductor paralysis of the larynx. Although the validity of this law has been challenged by many authorities, it is indisputable that in practice almost all cases of laryngeal paralysis present themselves with fixation of the vocal cords in or adjacent to the midline. When the lesion is long-standing this fixation is perpetuated by disuse atrophy of the affected cord and ankylosis of the crico-arytenoid joint. Mechanical fixation of one or both cords due to ankylosis has also been described by many authorities on repeated laryngeal infections.

Irradiation treatment for malignant disease is also a cause of fixation of the cords in or near the midline. Ankylosis of the crico-arytenoid joint closely mimic recurrent nerve paralysis, and when the fixation is bilateral it may become necessary to restore the airway by surgical means.

BILATERAL ABDUCTOR PARALYSIS

Bilateral abductor paralysis of peripheral origin is almost always due to injury to the recurrent laryngeal nerves during thyroidectomy. The nerves are most often

damaged during detachment of the thyroid lobes from the side of the cricoid cartilage, or they may be accidentally included in ligation of the inferior thyroid arteries. According to Thornell (1952) the incidence of bilateral abductor paralysis following thyroidectomy varies between 0.3-7 per cent, the difference being explained by the varying skill of the surgeons concerned and the proportion of difficult cases they are called upon to treat. One safeguard against this accident, which is not always observed, is routine pre-operative mirror examination of the larynx before all thyroid operations in order that the presence of an unsuspected unilateral palsy may be noted. Particular care can then be taken to avoid injury to the nerve on the other side.

Symptoms

Dyspnoea

The cardinal symptom of bilateral abductor paralysis is dyspnoea and its severity is influenced by several variable factors such as the rapidity of the onset of the paralysis, the age of the patient and the width of the glottic chink.

When the paralysis has developed gradually, as in many central cases, tolerance to laryngeal stenosis is more readily acquired and life is sustained with a reduced airway which would give rise to urgent dyspnoea if of sudden onset. Furthermore, owing to the nature of their illness many of these patients are elderly and bedridden, so that calls on their physical activity are slight. According to Lawson (1955) some vigorous young people also compensate quite well, and it is not until they reach late middle life that increasing muscular weakness, rigidity of the chest walls and chronic bronchitis lead to bouts of increasingly severe dyspnoea, particularly on exertion or when they are suffering from respiratory infections.

The width of the glottis is influenced by the completeness of the abductor paralysis. If it is complete the cords lie in the midline and respiration is only possible through the small gap in the posterior commissure of the larynx caused by the forward displacement of the arytenoids, which are no longer braced back by the posticus muscle. On the other hand, if the paralysis is incomplete slight powers of abduction may remain and the cords are then seen to be in the paramedian position on respiration. In such a case the airway is sufficient for moderate activities and this possibly accounts for the long delay that often occurs between the thyroid operations and the complaint of any serious difficulty in breathing. In all cases of bilateral paralysis breathing in is more impeded than breathing out, owing to the valvular shape of the vocal folds which tend to be sucked together on inspiration and blown apart on expiration.

Stridor

Stridor is often a marked feature, causing loss of sleep as well as social embarrassment. It is sometimes attributed to other causes, and the writer has seen a young woman who had been treated for asthma for seven years following thyroidectomy before the true nature of her disability was suspected.

Vocal changes

Speech is characterized by short cut-off phrases, interspersed with noisy inspirations which are too shallow to permit of normal sentences before the next crowing inspiration is due. The voice itself may be clear if the cords are in close apposition.

General activity

Owing to lack of oxygen, general activity is much reduced and a severe strain on the cardiovascular system may ensue.

SURGICAL TREATMENT

Spontaneous recovery of an abductor paralysis following thyroidectomy has frequently been observed. Mostly this occurs within a few months of the onset, but instances of

recovery as late as twenty months after the injury have been reported. Recovery of even one paralysed vocal cord will relieve the patient much more effectively than any operation so far devised; it is therefore extremely important that no premature procedure of a type likely to prejudice this possibility should be embarked upon. In practice this means that intervention must be limited to tracheostomy for the relief of threatened asphyxia until such time as all reasonable prospects of spontaneous recovery have been given up.

Tracheostomy

In performing tracheostomy it is desirable to intubate between the third and fourth rings of the trachea, well below the level of the cricoid cartilage. This allows the shield of the cannula to fit snugly in the lower part of the neck between the sternomastoid muscles, where it can be conveniently hidden by a collar or a scarf. A well-planned tracheostomy removes all risk to life or health, and restores the patient to full activity during the period of waiting for possible nerve recovery. A flap valve for speech purposes can be incorporated into the outer end of the tracheostomy tube; this valve opens on inspiration and closes on expiration, permitting of fluent speech. The resulting voice is often very satisfactory. A recommended pattern of tracheostomy tube is that designed by Negus, in which the outer end of the tube is slightly funnelled to allow the flap valve to be countersunk without encroaching on the lumen. In this way it fits flush with the neck and avoids unnecessary contact with clothing. Many patients, particularly the elderly, will be content with the relief which this operation provides and for them no further operative treatment need be contemplated. Younger patients, however, may find the wearing of a permanent tracheostomy tube irksome and request the alleviation of their disability by other means.

Nerve suture and nerve anastomosis

Nerve suture has been attempted and isolated successes have been recorded. In theory this should be the ideal treatment for restoring function to one or both damaged nerves, but almost all attempts have led to failure owing to technical difficulties such as the identification of the cut ends of this slender nerve, embedded as it usually is in dense scar tissue following the thyroid operation.

Ballance and Colledge (1927) carried out animal experiments to determine the possibilities of nerve anastomosis. They found that in the monkey, end-to-side anastomosis of the recurrent laryngeal nerves with the phrenic nerve led to normal movements of the vocal cord on quiet respiration. On killing the animal three years later, microscopical examination revealed complete recovery of the muscles and nerve concerned.

Barnes and Ballance (1927) performed this operation on a woman aged 52 years suffering from bilateral abductor paralysis after removal of an adenomatous goitre. Some return of movement was noted in one cord, abduction being about one-third of the normal. The other cord was uninfluenced by the operation and remained fixed in the midline. No other successes or partial successes following the operation of nerve anastomosis have been recorded, and the procedure has not established itself as a treatment for laryngeal paralysis.

Nerve section

Complete section of the damaged recurrent nerves to allow the cords to assume the cadaveric position of midway between abduction and complete adduction has been recommended, but the results have been uniformly disappointing. Section of the superior laryngeal nerve to relax the cords by paralysing the cricothyroid muscle has also been carried out, but without material improvement in the airway.

Excision of the vocal cords

Excision of the vocal cords by thyrotomy, or by per-oral methods, has also been attempted for the relief of bilateral abductor paralysis. Chevalier Jackson (1921) described the operation of ventriculo-cordectomy in which, by direct laryngoscopy, much of the vocal cord and floor of the ventricle on one side is removed with punch forceps; three weeks later the other side is similarly treated. Other surgeons preferred to open the larynx and to remove the vocal cord, as in the operation for intrinsic cancer. These operations failed because the raw granulating area in the larynx healed with the formation of a band of immobile scar tissue, which replaced the excised cord, with insufficient improvement in the airway and considerable impairment of the voice.

Ventriculectomy or ventricle stripping

This operation was originated by Williams (1906) for the treatment of recurrent nerve paralysis in horses. In this animal it is relatively easy to evert and excise the laryngeal ventricle and sacculus. The resulting raw surfaces in the ventricle adhere together, and thus place the vocal cord in abduction. Hobday (1921) improved on this procedure by entering the larynx of the horse through the cricothyroid membrane and stripping out both ventricles at the same time. He suggested that this operation might be used in the human subject, but Vlasto and others showed that the human ventricle differs materially from that of the horse, so that eversion is impossible without causing damage to the laryngeal mucosa. For this reason Vlasto (1921) concluded that the operation was not practicable in man.

Anterior cordopexy

Detachment of the anterior end of one or both vocal cords from the midline, and fixation outwards to the lateral wall of the thyroid cartilage to enlarge the airway through the anterior part of the larynx was proposed by Moore (1923) after experimental work on the cadaver. After splitting the thyroid cartilage vertically in the midline, a triangular piece of cartilage, to which the anterior end of the vocal cord is attached, is slid outwards along a horizontal incision through the thyroid ala for $\frac{1}{4}$ inch, leaving the cord anchored in a small circular opening in the alar cartilage at the outer end of the horizontal incision. In this way a considerable gap can be created in the anterior half of the larynx with resultant improvement in the airway, although with almost certain deterioration of the voice. Musgrave Woodman (1924) reported the successful restoration of the airway by this method in a girl aged 15 years suffering from bilateral abductor paralysis following the removal of a thyroid tumour. He stated that the vocal cords remained in their newly-placed position.

Posterior cordopexy

Fixation of the posterior end of one cord in abduction has been described by Rethi (1934). The larynx was opened by laryngofissure after preliminary tracheostomy, and an incision made in the mucous membrane behind the upper part of the arytenoid and under the vocal process. The crico-arytenoid joint was opened and the attachment of the adductor muscles divided. The arytenoid was displaced outwards and secured in this position by tamponage, thereby abducting the posterior end of the cord.

Rebattu (1950) also opened the larynx by laryngofissure and transfixed the vocal cords with sutures to the thyroid ala. In some instances he employed a suture anteriorly as well as posteriorly.

Extra-laryngeal route

This type of cordopexy was first described by King (1939). He believed that by an

extra-laryngeal approach to the crico-arytenoid joint an arthroplasty could be performed which would restore some power of abduction to the paralysed vocal cord. Although he soon acknowledged that, in fact, mobility did not return, he found that the outward displacement and external rotation of the arytenoid occasioned by his operation brought about sufficient improvement in the airway to allow the tracheostomy cannula to be discarded. Since King's publication, Kelly (1941), De Graaf Woodman (1949), Clerf (1950) and others have described similar procedures.

King's operation

Preliminary tracheostomy is carried out some weeks previously to avoid cough during convalescence. An incision $2\frac{1}{2}$ inches in length is made through the skin and platysma along the anterior border of the sternomastoid muscle from the upper border of the thyroid cartilage to its inferior cornu. The omohyoid muscle is identified and divided $\frac{1}{2}$ an inch below the hyoid bone. A ligature should be placed round the distal end of the muscle to help anchor the subsequent suture to the arytenoid. The posterior edge of the thyroid ala is defined and the fibres of the inferior constrictor muscles are divided along the line of their attachment. The pharyngeal mucosa is carefully separated away to expose the posterior surface of the cricoid and the arytenoid cartilage. The posterior crico-arytenoid muscle is divided at its insertion into the base of the muscular process of the arytenoid and the crico-arytenoid joint is opened by dividing the joint capsule. After severing the insertion of the inter-arytenoid and lateral crico-arytenoid muscles, adequate mobility of the arytenoid is secured. The vocal process is encircled by a chomicized catgut suture which is passed through a drill hole near the posterior border of the thyroid cartilage level with the vocal process. The cut omohyoid muscle is then attached by another suture round the arytenoid. At this stage the larynx is examined by direct laryngoscopy and the suture around the vocal process is tightened under vision until the required degree of abduction has been obtained. It is then tied over the edge of the thyroid ala leaving the arytenoid cartilage in a position of abduction and external rotation. King (1941) found that a minimum posterior gap of 3 millimetres is essential for the airway, but a maximum of 5 millimetres should not be exceeded if the voice is to remain good (Fig. 153). The wound is closed in layers with drainage. Since there was no return of mobility in the cord, King abandoned the use of the omohyoid attachment and contented himself with displacement of the arytenoid. In his cases the voice remained serviceable, the quality depending on the width of opening achieved.

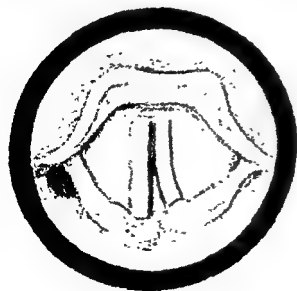


FIG. 153. The result of the King's operation.
(By courtesy of the Editor of *J. Laryng.*)

Clerf (1950) adopted a very similar technique, and reported on 66 cases. The airway was satisfactory in all and the voice was reasonably good except in one case where it was reduced to a loud whisper.

King's method presents some difficulties, as the exposure obtained is somewhat limited.

Kelly's operation

Kelly (1941) claimed that by excision of the arytenoid cartilage extra room for respiration was provided after healing was complete. To effect this removal the crico-arytenoid joint is approached through a window in the ala of the thyroid

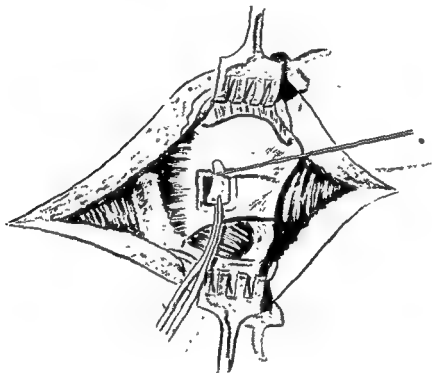


FIG. 154 — Kelly's operation. Freeing and delivering the arytenoid cartilage.

cartilage. For cosmetic reasons a horizontal incision is employed in a crease in the neck from the midline to the sternomastoid at the level of the lower border of the thyroid cartilage. The pre-tracheal muscles are exposed and divided. A window $\frac{3}{8}$ of an inch square is made through the cartilage in the lower posterior third of the ala, bringing into view the attachments of the thyro-arytenoid and lateral crico-arytenoid muscles to the arytenoid cartilage. The capsule of the crico-arytenoid joint is opened and by means of a hook the arytenoid is secured and dissected free of its muscular attachments (Fig. 154). A catgut stitch is placed through the posterior end of the cord, great care being taken to keep the stitch submucosal to avoid the risk of sepsis and subsequent granuloma formation. The arytenoid cartilage is lifted out through the window and the suture is secured to the external perichondrium to abduct the cord to the required extent; this is checked by examination through a laryngoscope. The divided muscles are sutured and the incision closed. Considerable difficulties are encountered in Kelly's operation due to the small size and depth of the exposure. Bleeding is also troublesome, and may make accurate insertion of the suture a matter of great difficulty.

De Graaf Woodman's operation

While agreeing with Kelly as to the need for removal of the arytenoid, De Graaf Woodman (1949) prefers the wider exposure afforded by King's approach, but with some modifications. After preliminary tracheostomy he introduces an intra-tracheal tube, which facilitates identification of the arytenoid by pressing it outwards. After incising the fibres of the inferior constrictor muscles at their attachment to the thyroid ala, he separates the perichondrium on the mesial aspect of the ala sufficiently to free it of its attachment to the constrictor muscle. To widen the exposure the facet-like joint between the inferior cornu and the cricoid cartilage is then separated, and the superior cornu is cut through at its base. The perichondrium on the lateral wall of the cricoid is incised and the incision is continued vertically upwards until the crico-arytenoid joint is opened. The arytenoid is dissected free of its muscle attachments and is disarticulated and rotated outwards to expose the vocal process. A curved atraumatic needle threaded with chromic catgut is passed round the vocal process, care being taken to keep it in the submucosa and to include some fibres of the thyro-arytenoid muscle. All the arytenoid is then removed except for the vocal process. The suture is drawn laterally and tied around the inferior cornu, or if that is deemed to be too low, through a drill hole in the thyroid ala. The intra-tracheal tube is then withdrawn so that the degree of abduction can be inspected by laryngoscopy before the knot is tied. The wound is closed with drainage. De Graaf Woodman quoted 24 cases, of which 21 followed thyroid surgery. The voice was good in 13, adequate in 9 and worse in 2. The airway was satisfactory in all. The advantage of De Graaf Woodman's operation over both King's and Kelly's is the better exposure which permits the arytenoid to be more easily identified and the suture to be placed with more accuracy.

Arytenoidectomy

Although much used in horses by veterinary surgeons before it was superseded by the ventricle stripping operation, the first record of its adoption in man was by Ivanoff (1913). The patient was a syphilitic on whom tracheostomy had been performed for bilateral abductor paralysis of the larynx. The larynx was opened and unilateral arytenoidectomy was carried out but with only temporary improvement, as the stenosis soon recurred. The favourable results obtained in arytenoidectomy with cordopexy, however, has led to the revival of interest in this method of treatment, either by the laryngofissure route or by suspension laryngoscopy.

Arytenoidectomy by thyrothussure

Removal of the arytenoid by this route was recommended by Owen (1952) as affording the simplest access to the arytenoid. After removal of the cartilage, haemostasis is obtained by diathermy coagulation to the bed—which later promotes further abduction—before the mucosal margins are drawn together. Experience of 7 cases successfully treated in this way has convinced Owen that simple removal of the arytenoid is all that is required to restore the airway, and that outward traction of the vocal process is unnecessary.

Thornell's operation

Preliminary tracheostomy must be carried out. With suspension laryngoscopy an incision 1 centimetre in length is made over the superior surface of the arytenoid extending laterally on to the aryepiglottic fold. By submucous dissection the muscular attachments of the lateral surface of the arytenoid are separated. The superior portion of the arytenoid is then rotated laterally so as to facilitate separation on the mesial aspect by the means of a very sharp laryngeal knife. It is extremely important to avoid tearing or injuring the mucous membrane of the lateral wall of the larynx,

since scarring in this area would nullify the attempt to increase the glottic opening. After removal of the arytenoid a guarded electro-cautery point is deeply inserted along the course of the thyro-arytenoid muscle, beneath the vocal cord, and into the space previously occupied by the arytenoid cartilage. What little bleeding occurs is easily controlled by the cautery. The incision is closed with one suture. An acrylic obturator is inserted between the cords to keep them abducted and is anchored to the tracheostomy tube below and the cheek above; it is removed after 5-7 days. The tracheostomy tube can usually be corked in 2 weeks and left out after 3-4 weeks. This operation, to those accustomed to working with suspension laryngoscopy, presents certain advantages and is said to be gaining popularity in the United States of America.

Submucous excision of the cord and arytenoid cartilage

Hoover (1932) introduced the method of submucous excision of the vocal cord after opening the larynx by laryngofissure. His purpose was to avoid granulation tissue formation with subsequent contracture and scarring, by leaving an unbroken epithelial surface in the larynx to cover the thyroid ala in spite of free excision of the vocal muscles. Beginning anteriorly by sharp dissection, the mucous membrane above and below the cord is separated to a point below the vocal process of the arytenoid, particular care being taken not to tear the thin and adherent mucous membrane of the ventricle. The soft tissues comprising the thyro-arytenoid and underlying lateral crico-arytenoid muscles are then separated from the thyroid cartilage and removed by means of fully curved scissors together with the vocal process of the arytenoid cartilage. The flap of mucous membrane is pressed into contact with the thyroid ala by means of a pack, the end of which is brought out through the cricothyroid membrane. The rest of the thyrotomy incision is closed. The pack is removed in 4-7 days and the tracheostomy tube in 1-2 weeks after preliminary corking of the

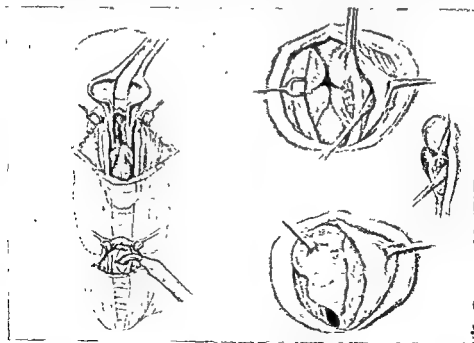


FIG 155—Tracheostomy and laryngofissure through separate collar incision. Submucous excision of alar cartilage.

(By courtesy of the Editor of the "Journal of Laryngology and Otology".)

tube. Hoover reported 4 cases in which the airway was good in all, the voice was good in 1 and impaired in 3.

Young (1955) has made certain important modifications in Hoover's operation. For cosmetic reasons he employs two collar incisions, the lower being for the tracheostomy if that is not already present (Fig. 155). After splitting the thyroid cartilage vertically he elevates the perichondrium from the outer and inner surface of

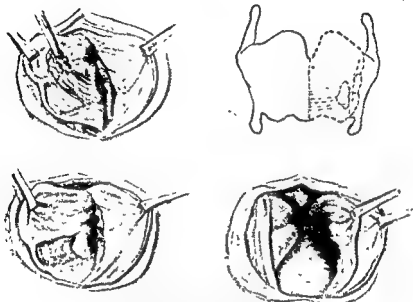


FIG. 156.—Stages in excision of musculus vocalis and arytenoid.
(By courtesy of the Editor of the "Journal of Laryngology and Otology".)

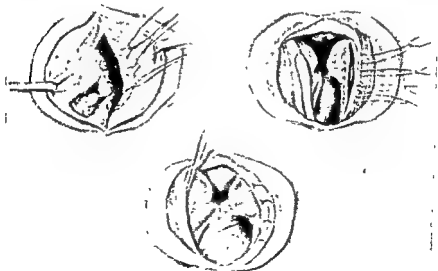


FIG. 157.—Method of obliterating cavity by mattress sutures.
(By courtesy of the Editor of the "Journal of Laryngology and Otology".)

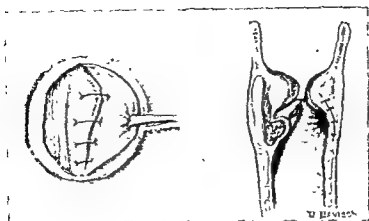


FIG. 158.—Final result of operation shown in Figs. 155-157.

the ala and resects the cartilage leaving only a narrow rim. He claims that this step, by eliminating denuded cartilage, promotes better healing, and, furthermore, that excision of this cartilage affords an extra 2 millimetres to the airway. Young states: "The musculus vocalis can then be isolated on the raw surface of the medial flap and peeled up like a sausage from before backwards as far as its insertion into the arytenoid (Fig 156). The whole arytenoid is resected with it and bleeding arrested by diathermy. The resultant cavity is obliterated by mattress sutures and the larynx closed in the usual manner (Figs. 157 and 158)." Speech is forbidden for 1 week and then actively resumed under the direction of a speech therapist. The tracheostomy tube is discarded in 1-2 weeks after preliminary corking.

Loré (1936 a and b) made a proposal, based on cadaver experiments, that after thyro-fissure a horizontal incision be made through the mucosa along the length of the vocal cord, so that flaps could more easily be turned up and down to facilitate excision of the vocal muscles as well as the whole arytenoid cartilage. The two flaps are then accurately sewn together and the larynx closed as in Hoover's operation.

Lawson (1955) has described a very similar technique. After opening the larynx he infiltrates the mucous membrane above and below the vocal cord with weak anaesthetic solution to raise it up, so as to facilitate its separation from the underlying structures. An incision is then made along the whole length of the cord 1 millimetre above its edge. A second similar incision is made parallel to the first 1 millimetre below the cordal edge. The mucous membrane is then elevated upwards and downwards and the cord and arytenoid excised (Fig. 159). After bleeding has been arrested the two flaps are accurately sutured together. No packs are used but the mucous membrane is fixed to the thyroid ala by several catgut mattress sutures. The wound is then closed (Fig. 160). Lawson states that while the voice may not be good following submucous excision of the cord, much can be done to help these patients by speech therapy. In all his cases the airway has been very good (Fig. 161).

Choice of treatment

Some of the operations described are of historic interest only, and in general it can be said that the choice now lies between permanent tracheostomy, arytenoidectomy, with or without cordopexy, and submucous excision of the vocal muscle and arytenoid. Many authorities agree with Owen (1952) that arytenoidectomy has played the major part in the success of the King or De Graaf Woodman type of operation and they question whether the lateral abduction obtained by the suture-cordopexy

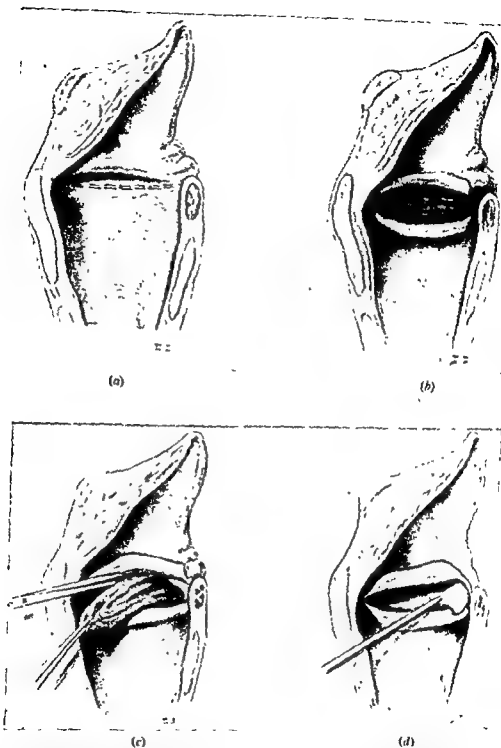


FIG. 159.—Stages of operation of submucous excision of vocal cord. (a) Lines of extension; (b) mucous membrane flaps raised; (c) thyro-arytenoid muscle being removed; (d) arytenoid cartilage being removed.

operation is of more than temporary duration. It is likely, therefore, that simple arytenoidectomy by thyrofissure or laryngoscopy may supplant the posterior extra-laryngeal approach. The width of the airway after a modified Hoover operation is likely to be greater than after arytenoidectomy, with or without cordectomy, and it is, therefore, the method of choice in more vigorous patients where the quality of voice is of less importance than freedom from obstruction. On the other hand, after

PARALYSIS OF THE LARYNX

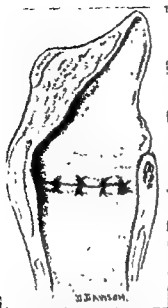


FIG 160.—Completion of operation of submucous excision of vocal cord. The final suture line of the mucosa
(By courtesy of the Editor of the "Journal of Laryngology and Otology")

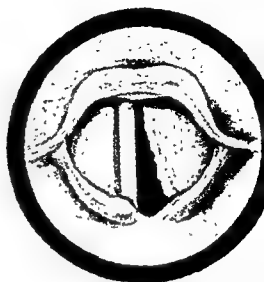


FIG. 161.—Larynx after a submucous excision of left vocal cord, showing extent of airway (from actual case).
(By courtesy of the Editor of the "Journal of Laryngology and Otology")

arytenoidectomy, with or without cordopexy, the voice will usually be more satisfactory.

Finally, it cannot be disputed that, apart from its aesthetic disadvantage, tracheostomy with the incorporation of a flap-valve will satisfactorily overcome laryngeal obstruction without any further disturbance of the voice

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MELANOMAS AND THEIR SPREAD

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Terminology

The terminology of melanoblastic neoplasms is confusing since some authors refer to all forms as melanomas, using the adjective benign or malignant; others restrict the term melanoma to the malignant form and designate the benign a pigmented naevus or mole. The latter nomenclature will be adopted here.

MOLES AND MELANOMAS

Melanomas comprise between one and two per cent of the malignant tumours. The great majority are primarily visible on the surface of the body and consequently allow the patient an opportunity, unsurpassed in malignant disease, of seeking medical guidance early.

The origin of moles and melanomas has given rise to controversy; much recent work lends support to the view of Masson (1951) that the essential pigmentary dendritic

cell tumours and pigmented carcinoma in xeroderma pigmentosum. They may be imitated by warts, ulcerating haemangiomas, pyogenic granulomas and sclerosing angiomas (fibroma simplex, histiocytoma, dermatofibroma).

Differentiation

In differentiating the mole from the melanoma the following are the main clinical features which favour malignancy:

(a) Rapid growth in a tumour arising *de novo* or increase in size of a previously benign lesion. The enlargement may be mainly of a circumferential nature or as an elevation from the surface.

(b) Discharge—serous, purulent or haemorrhagic—from the mass.

(c) Alteration in colour, usually a deepening in the degree of pigmentation.

(d) Signs of inflammation.

(e) Increasing firmness in consistency or induration at the base.

(f) Subjective sensations, usually irritation or a dull pain.

(g) Related lymph-gland enlargement or the appearance of metastases.

In a series of 50 cases of melanoma a pre-existing mole was found in 33; in 18 of these a history was given of direct injury shortly before the appearance of malignant changes. The figures approximate those in large collected series.

Age Incidence

When allowance is made for the diminishing number of patients in the older groups it is found that the age incidence of melanomas increases from puberty. Before puberty the condition is rare; the juvenile or pre-pubertal tumour may present the microscopical features typical of a melanoma and yet the subsequent clinical course is likely to be that of a benign lesion.

During pregnancy

In pregnancy melanomas frequently undergo rapid dissemination. The disease may or may not be transmitted to the foetus. Five years ago a patient was admitted in labour obstructed by melanomatous deposits in the pelvis. A live child was delivered by Caesarean section, the placenta being later examined histologically and found free of melanoma. The patient died a few months later; her child remains well.

Mode of spread

Local spread

The behaviour pattern of melanomas resembles that of skin cancers generally. Nevertheless, certain differences exist and require emphasis.

In transplantation experiments it is a rule that tumours capable of metastasizing, and also the metastases themselves, are hetero-transplantable. That melanoma nodes often fail to grow when transferred to guinea-pigs suggests that the rules for transplantation do not all apply for melanomas (Greene, 1950).

Again, the period between the appearance of a primary melanoma and that of a metastasis is frequently outside the time limit usually found in other malignant cutaneous tumours. This is most obvious in melanomas of the uveal tract where periods of up to 30 years may elapse between excision of the primary growth and manifestation of metastasis. The mode of dissemination in malignant neoplasms is accepted as being by blood-stream metastasis and by extension within the lymphatic system; the spread of melanoma conforms to this pattern. A primary melanoma may, however, be associated with a solitary melanomatous nodule in a distant region of the body and removal of both foci has been followed by apparent cure. If the nodule is a solitary metastasis, it represents a manner of spread which occurs rarely in the dissemination of other forms of malignant disease.

Such variations in the behaviour of melanomas demand an added caution in assessing operability and prognosis. Five cases, recorded by Wainwright (1933) and by Pringle (1937), in which operations were conducted early in this century for melanomas with advanced regional lymphatic involvement, show, by survival times which range from 15 to 38 years, the wariness with which one should apply general rules for operability in neoplastic disease to the treatment of melanomas.

The malignant transformation of more than one pigmented naevus in an individual patient is extremely rare. This observation would seem to favour local factors being responsible for the change, despite some evidence pointing to the existence of hormonal influences in the subsequent growth and rate of dissemination of the melanoma.

Whether malignant neoplasms of the skin arise from a focus in a bed of normal tissue or whether there is an alteration in the tissues locally which predisposes to the development of malignant change from multiple foci within the affected field remains controversial. The former view arose from Cohnheim's hypothesis of embryonic cell rests and, although the main concept has been largely abandoned, some pathologists believe that malignancy may start in a single group of cells and the growth enlarge by intrinsic cellular proliferation without alteration of the surrounding tissues. Willis (1948) strongly opposes this view. He writes "what is to be insisted upon is that a skin cancer in its early formative phase arises more by a general transformation of pre-existing epidermis than by cellular multiplication and only after the formative field has all suffered neoplastic change does the tumour grow solely by multiplication. The two processes, neoplastic transformation and proliferation, overlap, the former predominating during the early genesis of the tumour, the latter often being initially negligible but gradually taking increasing and finally exclusive part in the growth of the tumour". The potentially malignant area may therefore be much greater than the extent of the contained primary tumour and its boundary indeterminable—an aspect

PART II—CRITICAL SURVEYS

of major importance in formulating the extent of tissue removal needed for local eradication of the disease.

The classical studies of Dawson (1925) lend support to the multifocal nature of neoplastic tissue origin in the field of melanomas. Early cellular changes were shown not only in immediate apposition to the edge of the melanoma but at a distance from it. On serial examination of large adjacent tissue areas isolated groups of cells undergoing malignant transformation were seen.

In this connexion a case reported by Van den Brenk (1954) is of interest. It concerns the development of melanoma in both recipient and donor sites of an autogenous skin graft.

The patient, a male aged 68 years, developed a paronychia of the right thumb. The nail was removed but healing was defective and a graft was taken from the anterior surface of the right forearm and applied to the unhealed area of the thumb. Healing was still unsatisfactory and 9 months later the nail-bed and distal phalanx of the thumb were removed, a skin flap being thrown back over the dorsum of the digit. Healing followed but soon afterwards the patient noticed two dark spots in the thumb scar. The donor site also failed to heal, wart-like excrescences appeared and these later became dark in colour. The area was excised, it healed then broke down, dark rapidly-enlarging blebs appearing along the scar. At the same time the spots on the thumb grew and ulcerated. There was no apparent lymph-node involvement and no evidence of more distant spread. Interseculo-thoracic amputation was performed, subsequent examination of the operation specimen confirming the tumour on both the forearm and the thumb to be melanoma. Both patient and surgeon asserted that no lesion was present at the donor site before the graft was taken. Although the forearm lesion grew more rapidly than that on the thumb, the delay in onset of macroscopic malignant progression was similar, being a period of about 9 months from the date of grafting.

Two inferences may be drawn from this case: first, it lends support to recent experimental work upon specific "initiation" and non-specific "promotion" in the genesis of malignant tumours, secondly, the trauma of grafting, at donor and recipient sites, was the initiating factor and the subsequent scarring process the promoting stimulus. Alternatively it is possible that a growing tumour exerts an inhibitory effect upon the remainder of the adjacent altered tissues and that in the quoted case operation included the removal of malignant or potentially malignant cells from the donor site with consequent reduction of local inhibitory processes.

Distant metastases

The next problem is that of spread from cutaneous melanomas. Although it is accepted that extension is by the lymphatics and the blood stream, the exact mode of spread has not been fully elucidated. It is clearly a matter of great importance in formulating principles of surgical therapy.

Pringle, in 1908, described what he believed to be an original method for operating upon skin melanomas, and his proposals were widely adopted: Grey Turner strongly supported the method of treatment.

The principles advocated were: (a) "To surround the primary growth with an incision as far removed from it as is judged to be necessary; (b) To run from the most convenient point in this generally elliptical or ovoid incision a second one along the normal course of the main lymphatic trunks as far as necessary to allow free removal of at least the nearest lymphatic glands; (c) To reflect the whole of the subcutaneous side from these incisions, and excise the tumour with the whole of the fascia tissue exposed containing the lymph vessels, the deep fascia of the limb and the fascia propria of muscles exposed along with the lymphatic glands in one continuous strip."

The inclusion of the fascia propria is worthy of emphasis as it has often been omitted in subsequent descriptions of the method. Pringle met three cases of melanoma during the course of his surgical work; one was considered inoperable, and two were treated

according to the principles which he later published. The first, a girl aged 17 years, presented with a melanoma at the flexure of the left elbow; the axillary glands were involved. The second, a man aged 30 years, suffered from a melanoma of the inner aspect of the left thigh, the inguinal glands were extensively infiltrated with melanoma. On reviewing these cases in 1937 both patients were shown to be alive and free from recurrence of growth, the first 38 years and the second 30 years after operation.

These spectacular cases overshadowed later, less successful, series. It was assumed that, by meticulous excision of the tissue-strip superficial to the fascia propria of subjacent muscles in a line from primary growth to related glands, the lymphatic channels likely to be invaded were extirpated. This presupposes a direct and superficial lymphatic course from the primary lesion. Dissections have been made of limbs, amputated because of melanomatous infiltration, in order to check this and the findings are that the lymphatic involvement may lie more deeply than the plane of deep fascia. One case was a male aged 69 years with an ulcerating melanoma on the medial side of the sole of the right foot, pigmented spots adjacent to the ulcer, a mass of enlarged inguinal glands and no evidence of wider spread, who was subjected to hindquarter amputation. The limb was later dissected and 30 tissue specimens were removed for histological study. Of the glands examined the inguinal, external iliac and common iliac contained melanoma deposits: popliteal glands were not involved. Three skin specimens from skin areas near the primary ulcer were invaded and showed that skin involvement had occurred to at least 3 inches from the proximal edge of the lesion. In addition melanoma was identified in perivascular tissue immediately below the origin of the posterior tibial artery. Of the 12 specimens of deep fascia none was found to be the site of malignant infiltration.

A further example of this deep mode of spread was seen in a male aged 59 years for whom operation was performed for a melanoma on the dorsum of the right forearm with enlargement of the epitrochlear gland and also of a gland in the centre of the axilla. The primary lesion was removed with a wide margin of surrounding tissue. Through an incision extending from the anterior fold of the axilla to the medial epicondyle, the epitrochlear gland, the axillary glands and an intervening block of tissue deep enough to include the underlying perivascular elements were removed. Histological examination showed that the epitrochlear and axillary glands were invaded by melanoma although the latter were not macroscopically pigmented. In the perivascular tissue from a position $2\frac{1}{2}$ inches proximal to the epitrochlear gland a dark nodule was identified and was later shown to be melanomatous, this was not surprising. Gray (1946) describes the course of the lymphatic vessels passing across the medial side of the elbow as partly entering and partly by-passing the epitrochlear lymph glands. Both sets then pierce the deep fascia with the basilic vein and end in the lateral group of axillary glands or join the deep vessels. The basilic vein pierces the deep fascia below the middle of the upper arm so that removal of a strip of deep fascia from elbow to axilla is not likely to result in extirpation of the lymphatic channels in that region.

In the lower limb a proportion of the lymph vessels from the superficial tissues pierce the deep fascia to course along major vascular trunks: below the knee these drain into the deeper popliteal glands and course upwards along the femoral vessels to the inguinal region. Hence in both upper and lower limbs, particularly in the parts distal to knee and elbow, the lymphatic spread of melanoma to perivascular tissues beneath the deep fascia may be expected to occur. That it does so is seen in the two examples given and they indicate that the concept of complete removal of lymphatic vessels between primary growth and related glands by excision of a deep fascial strip is untenable except, possibly, in cases in which the primary growth is close to the lymphatic glands. Further investigations are being made into this aspect of melanoma spread.

PART II—CRITICAL SURVEYS

Melanoma may metastasize to any organ or tissue in the body. Bone metastases are rare; Geschickter and Copeland (1930) found them in 1.07 per cent of cases and a similar incidence was found by de Cholnoky (1941). The radiological picture of bone involvement is that of destruction and does not present specific features. Two examples are shown (Figs. 162 and 163), the first in the scapula of a male aged 56 years, and the second in the innominate bone adjacent to the sacro-iliac joint in a male aged 21 years. Both patients had advanced melanomatosis.

The final comment in considering the mode of spread of melanomas is that the spontaneous regression or cessation of growth in these tumours has been rarely recorded (Daland and Holmes, 1939, Willis, 1948). In 1955, Allen reported a most interesting case of spontaneous regression following pregnancy.

The patient, a female aged 37 years, was first seen in 1942. She complained of a pigmented lesion of the right forearm. This was excised and from its histological appearance was considered to be benign. Its nature was later reviewed and an opinion formed that it was a malignant melanoma. The following year a black nodule was seen in the scar and was excised, it was a melanoma. After a period of 10½ months, when in the seventh month of her fourth pregnancy, she presented with multiple bluish nodules subcutaneously on the left waistline, the right flank and the right upper arm. The last-named nodule was excised and found to be a lymph node almost entirely replaced by tumour. The prognosis was thought to be hopeless. Seven weeks later, 14 days after the birth of a normal child, further deposits had developed in the right scapular and inguinal regions together with localized masses of undetermined character in the left breast. She was again seen 2 months afterwards and all the nodules seen at her previous attendance had disappeared with the exception of a small node in the right groin. In June 1955, 12 years after the appearance of the widely scattered deposits, she was found to be entirely well.

Treatment

Radiotherapy

In the past many methods have been advocated for the treatment of melanomas. Broadly, the number of cases in various series has been small and the results not confirmed by subsequent investigators. The largest group is that in which either radium or x-radiation has been used. In assessing results it is difficult to exclude accurately tumours of the epidermis, either squamous cell or basal cell cancers, which happen to contain pigment. These give far better results from radiotherapy than the generally radio-resistant melanoma. It is important to recognize the fallacy that diminution of the primary growth necessarily improves the patient's survival period. In some cases this form of treatment has been seen to cause intense irritation and tissue activity, the very reaction that is to be avoided. Pack and Livingston (1940) reported 217 cases of melanoma treated by irradiation; in 5 cases the tumour disappeared and in 41 it decreased in size. Ackerman and Regato (1947) found a favourable response to irradiation in only 2 per cent of cases. There is some evidence that, as an adjuvant in the alleviation of terminal pain and discomfort, irradiation may be helpful. Irradiation of the pituitary gland has not been proved to be of value.

Surgical treatment of melanoblastic tumours

This subject falls into two categories. (1) the prophylactic excision of pre-melanotic lesions; and (2) the surgical ablation of established melanoma. Since each person has, on average, at least 20 visible pigmented naevi the advocacy of their wholesale removal is obviously impracticable, but those present on the body surface where they are subjected to repeated trauma should be excised. Examples are those of the scalp, the beard area and the hands, and those at sites where clothing or footwear may cause repeated friction as on the feet, ankles and pressure areas of the collar, braces, belt, brassiere or suspender. Urgent excision is to be recommended for



FIG. 162 —Secondary deposit of melanoma in right scapula. Male patient aged 56 years.

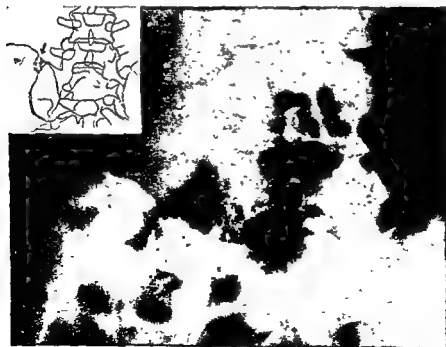


FIG. 163 —Secondary deposit of melanoma in the innominate bone. Male patient aged 31 years.

any pigmented naevus which may show changes indicative of melanomatous transformation—usually increase in size, alteration in colour, irritation, bleeding, serous discharge, infection, ulceration or enlargement of related lymph glands. Pigmented naevi of the palm, sole, scrotum, vulva and those in the region of the toe-nails and finger-nails should be regarded with great suspicion.

The malign effect of pregnancy has been emphasized and the surgical extirpation of moles which exhibit any suggestion of alteration together with those which are being subjected to repeated trauma should be advised as early as possible in the period.

Excision should be total and include macroscopically normal surrounding tissue; any form of partial removal is to be condemned. On the other hand a correct diagnosis of melanoma on clinical grounds alone is not possible except in the most advanced growths. Histological confirmation is essential in early cases and radical measures are not justifiable in the absence of such confirmation. Ewing and Powell (1951) have drawn attention to this in comparing the clinical and pathological diagnoses of 123 pigmented tumours.

The surgical treatment of confirmed melanoma requires elaboration in the light of the foregoing observations. Radical measures are essential and the extent of these measures may be sufficiently great to provoke opposition on the part of the patient who regards the primary lesion, often small and causing no symptoms, to be of trivial import.

The following are considered to be the principles in surgical treatment of melanoma, all patients being previously carefully examined to exclude generalized metastases.

Extent of tissue excision

The primary tumour should be removed together with a wide margin of surrounding tissue. But how can this wide margin be defined? If—and there is good evidence to show that melanoma grows in a field of tissue so altered that melanotic growth elsewhere in the field must be removed must remain. Indeed, the act of incising

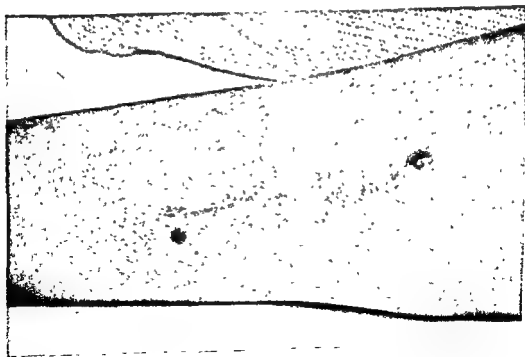


FIG 164 —Melanoma nodules in scar following wide excision of a primary melanoma



FIG. 165.—Melanoma of left ear with lymphatic gland metastases. Treatment consisted of wide circumauricular excision with block dissection of glands of neck on left side in continuity.

the inguinal ligament. A procedure whereby the anterior superior iliac spine is detached, the abdominal musculature incised vertically from the spine and the mass swung medially has been advocated. Division of the ligament and of the underlying femoral sheath, however, allows a thorough removal of perivascular tissues and has not been found hazardous from the viewpoint of post-operative weakness. Lymphorrhoea following lymphatic gland resection may be troublesome in the axilla and more so in the groin where healing is often further delayed by necrosis of the skin edges and by mild infection. A method of inguinal closure advocated by Lee (1955) (Fig 166) whereby a crescentic abdominal flap is rotated downwards to replace the defective tissues in the wound area has given good results.

Digital and subungual melanomas

Digital and subungual melanomas (Fig 167) should be treated by amputation of the digit at the metacarpo-phalangeal or metatarso-phalangeal joint with block dissection of the axillary or inguinal lymph nodes. More conservative ablation of the primary tumour is likely to result in recurrence (Fig. 168).

Melanomas of the foot

Melanomas in the forepart of the foot, the toes excepted, are best treated by a Syme or Pirogoff amputation. Melanoma in the proximal part of the foot, including

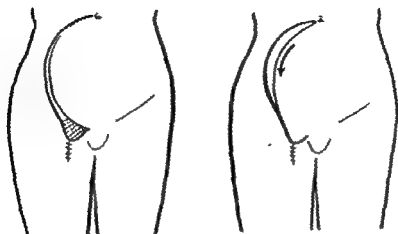


FIG. 166.—A method of filling the defect after block dissection of inguinal glands (after E. S. Lee)



FIG. 167.—Melanoma of thumb.



FIG. 168.—Recurrence of melanoma following inadequate local excision for primary melanoma of finger-tip

the heel, require amputation at the site of election in the lower leg with block dissection of the inguinal glands.

Oral melanomas

Melanomas of the oral cavity are treated according to the principles already enunciated. The post-operative fitting of a prosthesis may be necessary.

Anal melanomas

Melanomas of the anal canal require most radical treatment which should consist of abdomino-perineal resection of the rectum with bilateral iliac node excision, the wide peri-anal section being continued on each side to include both sets of inguinal glands

Melanomas of the genitalia

Melanomas of the genitalia should be treated by wide excision and bilateral inguinal block dissection in continuity.

Pre-pubertal melanomas

Pre-pubertal melanomas should be excised in the manner already advocated but removal of related lymph nodes is not performed as a routine since metastasis is exceptional.

Surgical treatment during pregnancy

The surgical treatment of melanoma in pregnancy is of the utmost urgency. The pregnancy should be terminated. Sterilization is not indicated since patients who have had melanomas adequately excised and have remained free of recurrence for several years have passed through subsequent pregnancies without recurrence of melanoma.

Nerve section

Palliative surgery has a place in the removal of a large fungating growth in the

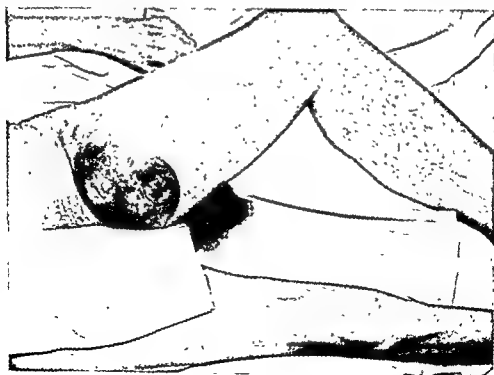


FIG. 169 —Left inguinal and lower abdominal metastases causing severe pain, treated by dorsal chordotomy.

presence of general metastasis. Occasionally, nerve section is called for in the patient with inoperable melanoma who is suffering intractable pain (Fig. 169)

Late results

In spite of the poor prognosis when lymphatic glands are involved pre-operatively, there have been a number of recorded cases where apparently inevitable early death has not followed and hence a degree of optimism is required in order that hesitation is exercised in the labelling of a growth as inoperable unless general metastases are present. Pack and Livingston (1940) reported excision of a primary melanoma in the skin of the chest wall with axillary node dissection. In subsequent operations over a period of several years metastases were removed from the scalp, trunk, back, arms and opposite axilla. The patient was well with no further recurrence 10 years later. Wainwright (1933) reported excision of a melanoma overlying the right scapula with axillary gland involvement in 1905; in succeeding months metastatic tumours were removed from the left shoulder and opposite axilla, the melanomatous nature of all tumours being confirmed microscopically. This patient was well more than 27 years later. Pringle's 2 patients, both with gross glandular involvement initially, were well 30 and 38 years later.

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Obstruction of the pancreatic duct

The suggestion that obstruction of the pancreatic duct in an actively secreting gland might cause acute pancreatitis has been generally credited to Rich and Duff (1936). Obstruction may be due to inflammatory oedema, calculus, tumour, abscess, cyst, haematoma or, as they specifically suggest, squamous metaplasia in the ducts. Hess (1909), Wangenstein (1931), Lium and Maddock (1948), and Coffey (1952), among others have produced pancreatitis experimentally by combining ligation of the pancreatic ducts with stimulation of the gland. Carcinoma of the head of the pancreas may obstruct the pancreatic duct without the development of pancreatitis. Cannon (1955) has ligated the pancreatic duct, thus destroying the exocrine function of the gland, in the treatment of recurrent pancreatitis.

Vascular theory

The view that acute haemorrhagic pancreatitis may have a vascular component in its aetiology is not new. Panum (1862) produced haemorrhage into the pancreas by injecting small particles of wax into the pancreatic arteries. Langerhans (1890), Lépine (1892), Bunge (1903), and Smyth (1940) have all induced experimental pancreatitis by

experimentally that oedematous pancreatitis can be transformed into the haemorrhagic type by temporarily occluding the pancreatic arteries.

An autopsy on one of our patients who died from multiple emboli in a case of mitral stenosis revealed haemorrhagic pancreatitis in the distal half of the pancreas produced by an embolus lodged in an artery to the gland. This would appear to be a case of acute haemorrhagic pancreatitis in which ischaemia was the initiating factor.

Adams and Musselman (1953) have postulated thrombosis of pancreatic veins as a cause of haemorrhagic pancreatitis rather than a result. By ligation of the veins at various sites and the injection of either topical thrombin or lyophilized trypsin they created a thrombosis in the vein and a pancreatitis in the portion of the pancreas involved. Acute interstitial pancreatitis may suddenly be converted into a fulminating haemorrhagic or necrotic pancreatitis by the development of venous thrombosis. Levels of trypsin, amylase and lipase are high in the pancreatic vein in acute pancreatitis. The trypsin, being proteolytic, converts prothrombin to thrombin and causes blood coagulation.

Thal (1955) noted the similarity between the rapidly developing vascular lesions seen in the dermal Schwartzmann reaction and that of acute haemorrhagic pancreatitis. He perfused the pancreatic ductal system of rabbits with either meningococcal or *Escherichia coli* endotoxin. All ductal injections were performed well below the pressure required to produce ductal rupture. Rapid diffusion of the bacterial toxins through the intact ductal wall was repeatedly observed. Twenty-four hours later the local Schwartzmann reaction was induced by intravenous injection of the same toxin. All rabbits were ill within 3 hours and all died in from 4 to 24 hours after administration of the challenging dose. Death in these animals was due to acute haemorrhagic pancreatitis.

In controlled experiments, where either the sensitizing dose or the intravenous provocative dose was omitted, pancreatic necrosis failed to occur in all animals. By examining tissues from animals sacrificed at varying intervals following the provocation of the local Schwartzmann reaction in the pancreas, it became clear that venous and capillary thrombosis regularly preceded the pancreatic necrosis and haemorrhage. We have all seen similar lesions in human autopsy material. The findings of Thal (1955) are obviously important in relation to the disease in man by indicating a mechanism whereby toxins or micro-organisms present in the bowel or upper gastro-intestinal

tract may sensitize the pancreatic blood vessels. Schwartzmann has shown that the vascular lesion is readily produced in such sensitized tissues by the presence in the systemic circulation of a number of biologically unrelated substances. Meningococcic toxin and toxins from *E. coli*, *Proteus*, and *Salmonella typhosa* will all produce the same phenomenon. All of these organisms may occur in the upper reaches of the duodenum in which they or their products may perfuse the biliary and pancreatic systems.

Trauma

Acute pancreatitis may follow trauma, such as gun-shot wounds, stab wounds, crush fractures or injuries from automobile steering wheels. Operative procedures such as choledochostomy or gastrectomy for a posterior wall penetrating ulcer may be followed by pancreatitis. The overall mortality rate for post-operative pancreatitis is in the vicinity of 50 per cent. In 12 cases in our hospitals 7 proved to be fatal.

Miscellaneous

The frequent association of pancreatitis with acute and chronic alcoholism is well known. The mode of action may be that of obstruction of the pancreatic duct in an actively secreting gland. Alcohol stimulates acid secretion in the stomach and the subsequent increase in acid chyme in the duodenum causes hypersecretion of the pancreas by the action of secretin. The duodenitis which accompanies prolonged ingestion of alcohol may produce obstruction by initiating spasm of the sphincter of Oddi. Menguey (1955) has carried out some very interesting unpublished studies in experimental pancreatitis. He demonstrated that alcohol introduced into the duodenum causes a rapid rise in the resistance of the pancreatic and biliary sphincters and a concomitant marked rise in intra-pancreatic duct pressure. The rise in pancreatic duct pressure after alcohol was greater when alcohol was introduced into the duodenum following a meal. A significant rise in biliary pressure occurred only in cholecystectomized animals.

The production of acute pancreatitis by the administration of ethionine in the diet of animals has been reported (Kaiser and Grossman, 1954). Ethionine is an analogue of the amino acid methionine and it is antagonistic to methionine. It produces pancreatic necrosis and insufficiency with a damaging effect on enzyme manufacture and release. This work stresses the importance of the availability of adequate protein in the prevention of pancreatic damage and insufficiency (Bockus, 1954). The chronic alcoholic invariably suffers from dietary insufficiency and lack of available protein. This mechanism may provide the relationship between alcoholism and pancreatitis.

The spread of infection from the gall-bladder by lymphatic or ductal routes, mumps, and hepatitis are also included among the causes of acute pancreatitis.

CLINICAL ASPECTS

In our own experience with acute pancreatitis 30 per cent of patients were classified as acute haemorrhagic pancreatic necrosis. The remainder were classified as acute oedematous pancreatitis. This latter group might well have been misdiagnosed prior to the advent of the serum amylase estimation. The youngest patient in our series was aged 20 years; the eldest 84 years. The average age was 50 years. There were 56 males and 41 females in the series of 97 cases of acute pancreatitis. The incidence of associated gall-bladder disease varied from 25 per cent in males to 50 per cent in females. It should be emphasized that radiological examination of the gall-bladder carried out during the acute attack of pancreatitis is not reliable. If, however, the examination is repeated 7-14 days after the acute episode the gall-bladder will often visualize normally.

In the typical case of acute haemorrhagic pancreatitis the patient frequently after

eating or over-indulging in alcohol is seized with severe, sudden, agonizing pain in the upper abdomen. The pain is often steady, occasionally colicky, and radiates to the back and to the flanks. Nausea and profuse vomiting follow in the wake of pain. Tenderness with minimal upper abdominal rigidity is present, but is noted later than in other lesions producing an upper abdominal catastrophe. In our series 1 patient was moribund on admission, 4 fulminating cases went on to expire 2-5 days after admission to hospital in spite of very energetic supportive treatment including blood transfusions, antibiotics, and in several cases ACTH and cortisone. We are inclined to agree with Kirby, Howard and Rhoads (1955), who have recently said that there is little we can do to reverse the disease process in acute fulminating pancreatitis. The severity of the clinical picture appears to vary directly with the degree of the pathological changes found in the pancreas. Ileus, abdominal distention, and fever, to be followed later by a localized abscess in the upper abdomen, is the usual course of the patient with a necrotic lesion who survives the initial catastrophe.

Our experience with the serum amylase estimation has made us feel that it is very dependable. We have reported a study of serum amylase activity as determined in approximately 400 consecutive surgical patients pre-operatively and post-operatively. In all cases the blood for estimation of the enzyme was taken before sedatives were administered in order to avoid an elevation of amylase activity associated with spasm of the sphincter of Oddi incident to pre-operative medication. Occasionally other abdominal conditions such as a perforating or penetrating ulcer may also exhibit high serum amylase determinations making differential diagnosis difficult. No test should be regarded as infallible and it is necessary to appraise each abdominal emergency carefully, re-examine and re-evaluate the patient frequently, if we are to avoid the error of withholding operation in patients in whom it might have been life-saving.

A scout film of the abdomen may be of value. In our series 25 per cent of the cases demonstrated a segmental ileus. Diabetes mellitus was present in 3 patients at the time of admission, 2 of whom had previous attacks of pancreatitis. Diabetes developed in an additional case as a sequel to the attack of acute pancreatitis. Tetany, owing to the lowered serum calcium level, may develop on rare occasions on the fifth or sixth day, in only 1 patient in our series it occurred shortly before death on the fifth day of the disease.

TREATMENT

Prevention or reduction of pancreatic enzyme production

If the diagnosis can be definitely established, a conservative regime should be followed. The prevention or reduction of pancreatic enzyme production is one of the prime aims in therapy. Acid in the intestine causes liberation from the intestinal mucosa of the hormone secretin which stimulates pancreatic secretion via the bloodstream. This explains the prompt secretion of pancreatic juice from the passage of acid chyme into the duodenum. It has more recently been shown that peptones, proteoses and some of the products of digestion of fat which are present in the intestine are pancreatic secretagogues. They produce a secretion rich in nitrogenous material. This mechanism may be explained by the liberation of pancreozymin, a hormone which is derived from the intestinal mucosa and stimulates the pancreas to secrete a juice rich in enzymes. The pancreatic gland has a special nervous mechanism which regulates the discharge of enzymes, and which seems to have little relation to the secretion of the liquid parts of the juice; this mechanism is controlled by the vagus nerve.

The importance of secretion of enzymes in initiating pancreatic injury in the presence of duct obstruction, or in aggravating the insult produced by reflux or vascular occlusion, cannot be over-estimated. Nasogastric tube aspiration and the withholding of fluids and food by mouth are first principles in the treatment of acute pancreatitis.

The tube should be placed in the pre-pyloric portion of the stomach, in an effort to prevent any gastric content proceeding into the duodenum.

Supportive therapy

In addition to pancreatic rest, supportive measures are of great importance. Zollinger, Keith and Ellison (1954) have been very interested in the blood volume deficits in patients with acute pancreatitis. They have used radioactive iodinated human serum albumin to measure the blood volume in these patients. In general they have found a definite fall in the plasma volume as well as some fall in the red cell mass in the majority of patients with acute pancreatitis. They have been treating these patients with blood and serum albumin and feel that restoration of sufficient plasma volume is the effective agent rather than the antitryptic effects of these substances as has been suggested by Kenwell and Wels (1953). Elliott and his colleagues (1955) have induced pancreatitis experimentally by retrograde injection of bile into the pancreatic ducts which ordinarily has resulted in death of the animals. They found, however, that dogs will recover from this experiment if a sufficient amount of serum albumin is administered. They are of the opinion that the efficiency of the albumin is not due to its antitryptic effect but rather to the replacement of deficient plasma volume.

Regardless of the mechanism by which blood or albumin produces its beneficial effect it suffices to say that the seriously ill patient suffering from acute pancreatitis requires intensive supportive therapy including blood and blood substitutes.

Attention has been directed to the dangerous degree of hypochloraemia and hypocalcaemia which may occur in pancreatic necrosis. Electrolyte levels must be controlled by frequent blood estimations and prophylactic administration. Caloric needs can be met by intravenous glucose or invert sugar. Carbohydrate metabolism must be carefully managed and insulin coverage is mandatory because either hypoglycaemia or hyperglycaemia will stimulate pancreatic secretion (Babkin, 1950).

Control of pain

To control pain Demerol is probably the drug of choice and should be used intravenously if the patient is in shock. Nitrites, such as amyl nitrite, have their place in treatment in the absence of shock. The relief of sphincter spasm and resultant pancreatic duct decompression may dramatically relieve the pain and modify the severity of the attack. Atropine is effective in reducing enzyme output and counteracting spasm of the sphincter of Oddi which usually accompanies the use of opiates. Epidural procaine blocks have been used successfully in the alleviation of pain. The effect of the block on the course of the disease is unknown. The beneficial effect of hexamethonium bromide, a ganglion-blocking agent, has been reported recently but results from its use have been variable.

Antibiotic therapy

The antibiotics have been credited not only with reducing the mortality of the disease but also with markedly reducing the complications of acute pancreatitis. Abscesses have responded well to antibiotic therapy. Five of 7 cases in one series cleared under antibiotics without drainage (Hay, 1954). Kirby, Howard and Rhoads (1955) believe that antibiotics and adequate supportive measures may prevent many deaths from infection and secondary haemorrhage.

as variable as acute pancreatitis.

Surgical treatment

Surgical treatment was carried out in 25 patients with acute pancreatitis in our series. Most of these cases were acute upper abdominal emergencies in which the

diagnosis of pancreatitis could not be made pre-operatively and in which it was considered more serious to overlook a perforated or gangrenous viscus than to perform a laparotomy on a patient with pancreatitis. Three cases showed a progression of the associated cholecystitis and one a deepening jaundice. If operation is performed adequate drainage of the fossae should be carried out along with cholecystostomy if the gall-bladder is present. In the absence of biliary-tract disease Baker and Boles (1955), despite lack of belief in the efficacy of decompression, still favour cholecystostomy routinely by means of a Pezzar catheter. Such a catheter, besides providing decompression, is useful for post-operative cholangiography. Of the patients operated on later in the course of the disease, 50 per cent were subjected to an operative procedure on the biliary tract. In the remainder of this group the pancreatic area was the primary site of the operative procedure. The indication for operation was the presence of pseudocyst or a residual lesser sac collection.

Definitive operations are required for the treatment of abscesses. The latter will increase in frequency as more cases of severe pancreatitis survive the initial attack. When pancreatitis and cholecystic disease occur together elimination of gall-bladder disease very frequently prevents further attacks of pancreatic disease. Early operation may prevent the serious late manifestations of recurrent pancreatitis.

RECURRENT OR RELAPSING PANCREATITIS

Recurrent or relapsing pancreatitis can best be defined as that entity in which acute and subacute attacks of pancreatitis recur with varying frequency, usually with freedom from each attack the pancreas develops in the necrotic areas. Atrophy is often marked, but occasionally at operation the pancreas may be slightly enlarged and oedematous.

The progressive pathological changes in the gland are usually accompanied by recurrent clinical episodes. In rare instances, however, fibrotic lesions of the pancreas may be found wasting, steato-

The most likely cause of relapsing pancreatitis appears to be some toxin or condition associated with hypersecretion of the pancreas. It seems unlikely that trauma, vascular abnormalities, or virus infections are often the cause of the relapsing form of the disease.

Medical management by diet, antispasmodics, anticholinergics and sedatives has been unsuccessful in the control of the recurrent form of pancreatitis. Chronic alcoholism and drug addiction have been frequently reported. Some patients may be improved if the alcohol intake is curtailed.

Operation of associated

In 1950 a female aged 21 years was admitted with severe epigastric pain from the acute attack. Serum amylase content. The gall-bladder was explored. Her first hospitalization, but later examinations revealed the presence of stones. She was readmitted and at the time of cholecystectomy the pancreas was found to be slightly enlarged, firm and oedematous. The common bile-duct was not explored because it was small and did not contain calculi. She has been well since the cholecystectomy was performed.

Elimination of cholecystic disease is usually sufficient to produce relief from further attacks of pancreatitis and it is this group of cases that affords the best results.

At the time of cholecystectomy, if the common bile-duct is dilated and the pancreas hard and fibrotic, operative cholangiography should be carried out followed by common duct exploration. Cholangiograms may demonstrate residual stones in the duct.

Case 2. S.P. In 1952, a male aged 50 years was admitted to the University Hospital with recurrent episodes of epigastric pain. His gall-bladder had been removed 10 years before for gall-stones; there was no history of subsequent jaundice. His serum amylase was markedly elevated on several occasions and a diagnosis of recurrent pancreatitis was made. At operation the head of the pancreas was hard and slightly enlarged. An operative



FIG 170—Operative cholangiogram demonstrating residual common bile duct stones causing recurrent attacks of pancreatitis

cholangiogram revealed the presence of calculi in the common bile-duct which had not been palpable (Fig 170). The duct was explored and the stones were removed; the sphincter of Oddi was dilated easily to 7 millimetres with Bakes' dilators, T-tube drainage of the common bile-duct was continued for 3 months. He has been free from recurrent attacks since the time of his operation.

Prolonged T-tube drainage aids in decompression of the biliary tract and has been reported upon favourably by the Mayo Clinic group in the treatment of the recurrent pancreatic lesion. When the tube is removed, however, the same conditions prevail as prior to its insertion and it is difficult for us to rationalize this form of therapy in this disease.

The operative cholangiogram may also aid in ascertaining the tone of the sphincter of Oddi. In the presence of spasm of the sphincter reflux of dye into the pancreatic duct may be demonstrated.

Case 3. M.R. In 1951, a female aged 59 years was admitted to the University of Alberta Hospital complaining of recurrent attacks of epigastric and right upper quadrant pain.

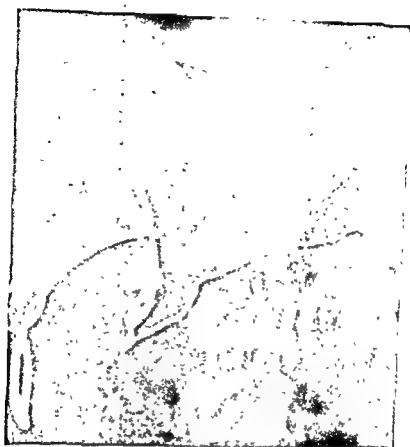


FIG. 171.—Reflux of opaque medium into pancreatic duct due to sphincter spasm

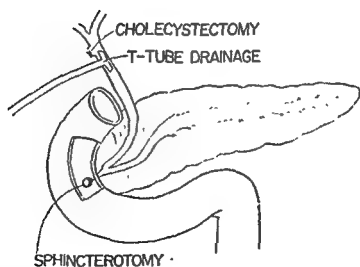


FIG. 172.—Diagrammatic representation of sphincterotomy in Case 3. Previous choledochostomy had failed to relieve recurrent attacks of pancreatitis.

She had had cholecystectomy performed 20 years before for cholelithiasis. Serum amylase determinations on this admission were markedly elevated. At operation the pancreas was found to be hard and nodular. Common bile-duct exploration was carried out and T-tube drainage instituted. A cholangiogram was performed by injecting dye through the T-tube and it showed a reflux of dye into the pancreatic duct (Fig. 171). The T-tube was left in place for 4 months and soon after its removal the pain recurred. In 1953 the patient was re-explored; the pancreatic disease was more marked and a trans-duodenal sphincterotomy was performed to relieve spasm of the sphincter of Oddi (Fig. 172). The T-tube was removed in 6 weeks and the patient has been free from recurrence of pain since the time of the last operation.

It is evident to us, from a review of this case, that the post-operative cholangiogram demonstrated sphincter spasm and that a sphincterotomy should have been carried out at the time of the 1951 procedure.

Over 30 years ago Archibald (of Montreal) made original fundamental and clinical observations on the importance of sphincter spasm as the cause of pancreatitis and carried out sphincterotomy in the treatment of the recurrent lesion. Doubilet and Mulholland (1951) have continued the work of Archibald and have been enthusiastic about sphincterotomy in the relief of relapsing pancreatitis. If the sphincter of Oddi cannot be dilated readily at operation a trans-duodenal visualization of the ampulla is indicated. Doubilet (1955) has advocated the use of amyl nitrite at the time of exposure of the ampulla to demonstrate release of spasm and thus differentiate spasm from stenosis.

Case 4. M.J. In 1950, a female aged 43 years was operated upon for obstructive jaundice due to calculous obstruction of the common bile-duct. After removal of a calculus, the sphincter of Oddi was dilated to 8 millimetres with Bakes' dilators. At the time of operation, the pancreas was noted to be hard and nodular. T-tube drainage during the next 2 months afforded relief and the T-tube was removed. The patient remained well for a period of 2 years before developing recurrent episodes of epigastric pain with an elevated serum amylase. She was finally readmitted with jaundice. At operation trans-duodenal exploration revealed a stenotic scarred ampulla of Vater. A side-to-side choledochoduodenostomy was carried out (Fig. 173). The jaundice cleared and she has been free from pain since that time.

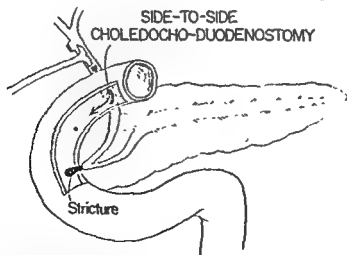


FIG 173—Choledochoduodenostomy to relieve the stenotic obstruction to the sphincter of Oddi. Previous sphincter dilatation had failed to relieve recurrent attacks of pancreatitis.

Sphincterotomy or sphincter dilatation is less effective in the treatment of fibrotic stricture of the sphincter of Oddi than it is in the treatment of spasm because in the former lesion scar contracture tends to recur. Some short-circuiting or decompressing procedure, such as a cholecysto-jejunostomy or side-to-side choledocho-duodenostomy, is more satisfactory than sphincterotomy. The Roux-Y type of anastomosis reduces the risk of cholangitis and Bowers (1951) claims that the danger of stricture is not great in good hands. Most surgeons hesitate to transect the common duct for any condition less than malignancy and prefer a side-to-side choledocho-duodenostomy to decompress the biliary tract.

Small pancreatic cysts in the head of the gland may cause obstruction of the pancreatic duct and recurrent attacks of pancreatitis.

Case 5. R.R.: In 1949, an alcoholic aged 43 years was admitted to the University of Alberta Hospital with a history of recurrent bouts of epigastric pain. An increased serum amylase was a constant finding with the attacks. He was found to have cholelithiasis and the gall-bladder was removed. At the time of operation the common duct was normal but the pancreas was hard and nodular, the common duct was drained. The patient was well

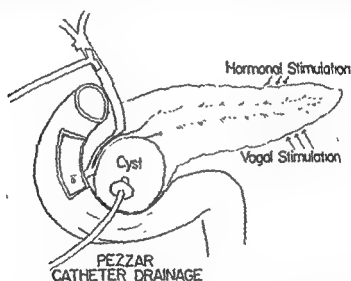


FIG. 174.—Cyst in pancreatic head causing obstruction to secretory flow of pancreas relieved by Pezzar catheter drainage

head obstructing the duodenum. A palliative gastro-enterostomy was performed and the mass subsided with the aid of antibiotics and supportive measures. The pain continued and 6 months later he was re-explored. A cystic mass, 5 centimetres in diameter, was found in the pancreatic head. The cyst was drained by means of a Pezzar catheter (Fig. 174) and the gastro-enterostomy was taken down as the duodenum was no longer occluded. He continued to drain for many weeks but finally healed completely, and has been free from attacks since the last operation, in spite of the continued use of alcohol.

Drainage of small cysts of the pancreas by a Pezzar catheter is simple and effective. Cysts of the body and tail may also be treated by excision of the distal portion of the gland if cysts are small. Marsupialization or anastomosis to stomach or jejunum (Puestow, 1953) may also afford decompression and drainage.

It has been previously mentioned that fibrotic lesions of the pancreas may be encountered without demonstrable clinical findings

Case 6. S.H.: In 1949, an elderly patient was admitted to the University of Alberta Hospital with painless jaundice, anorexia, and weight-loss. Pre-operative diagnosis of a

malignancy of the pancreatic head or ampulla of Vater was made. At operation biopsies from the superficial portion of the hard mass in the pancreatic head revealed only inflammatory changes. Biopsy of the regional lymph nodes and a needle biopsy of the central portion of the mass also failed to reveal malignancy. Anastomosis between the normal gall-bladder and the jejunum relieved the symptoms completely and the jaundice cleared.

Incisional biopsies of the pancreas are dangerous. Injury to a major duct may allow liberation of trypsin-rich fluid and result in a haemorrhagic pancreatic necrosis; needle biopsy is safer. Smith (1953) describes a trans-duodenal biopsy either with a

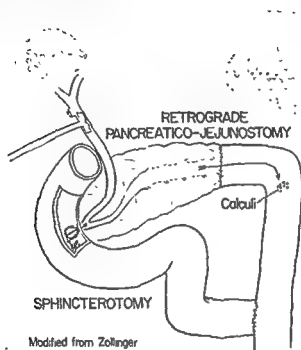


FIG 175—Retrograde pancreatico-jejunostomy by Roux-Y combined with sphincterotomy
(Modified from Zollinger, 1955)

diathermy or with an ophthalmic trephine. We have found that diathermy distorts the microscopic picture. A radical Whipple type of operation has occasionally been carried out on this type of lesion, suspecting cancer, only to find that the patient had been subjected to extensive surgery for a benign lesion.

In the absence of biliary-tract disease and lacking evidence of obstruction of the sphincter of Oddi, the pancreatic duct must be explored for evidence of obstruction. Coffey (1955) explores the pancreatic duct at the time of trans-duodenal sphincterotomy and by using a polyethylene catheter has irrigated the pancreatic duct. The use of opaque medium through the catheter is useful in detecting residual calculi. If a calculus should remain in the duct and not be removed by irrigation Priestley (1952) has described a procedure for opening the duct, removing the stones and closing the duct over a T-tube, which is removed at a later date.

Du Val (1954), Zollinger (1954), Aird and Buckwalter (1955), and others have all been interested in the retrograde drainage of an obstructed pancreatic duct by means of a pancreatico-jejunostomy. This may be accomplished either by end-to-side anastomosis of the pancreas to jejunum, or by an end-to-end anastomosis of the pancreatic duct to jejunum by a Roux-Y (Fig 175). At the time of this anastomosis the distal end of the pancreatic duct can be probed to remove residual calculi and afford a free flow of pancreatic juice in a retrograde direction.

Longmire (1955) reports a case of retrograde decompression of the pancreas in which the changes of relapsing pancreatitis were found in aberrant pancreatic tissue. In this case, during re-exploration, trans-duodenal injection showed the entire duct to be patent. This patient had relief after the main duct was ligated, destroying the exocrine function responsible for the disease.

Cannon (1955) has described the successful use of ligation of the pancreatic duct in the treatment of this disease, preserving the endocrine function of the pancreas. The procedure is technically difficult by use of the trans-duodenal or extra-duodenal route and often not successful if the duct of Wirsung alone is tied.

Splanchnic blocks, by procaine or alcohol, give relief for an indefinite period of time.

Bilateral dorsal sympathectomy has proved effective in the control of pain which has become intractable. Failure of dorsal sympathectomy to relieve pain in advanced cases may be explained by the involvement of somatic nerves. Grimson (1955) has reported successful long-term follow-up of 9 cases treated by the removal of the celiac ganglia.

Case 7, S.B. In March 1952, a male aged 47 years was admitted to the University of Alberta Hospital with epigastric and right upper quadrant pain. A cholecystectomy had been carried out elsewhere one year previous to admission. The gall-bladder was normal on pathological examination. He had many recurrent episodes of pancreatitis with marked elevation of serum amylase and his pain was intractable. He required a large amount of sedation and was considered to be an addict. At operation the entire pancreas was hard, nodular, and fibrotic, and sphincterotomy was carried out with no relief. Subsequent radiological examination of the pancreas demonstrated diffuse calcifications throughout the entire pancreatic substance. In October 1952 a bilateral thoraco-lumbar sympathectomy and splanchnicectomy was performed, and the patient has since been free from pain and has had only one febrile episode 6 months after operation.

Partial or total pancreatectomy is of value in the presence of numerous small cysts, parenchymal calcification, gross destruction of the normal architecture, and in patients with persistent pain, in contrast to the intermittent pain seen in the early phase of relapsing pancreatitis. In our opinion a limited resection of the body and tail of the pancreas is a justifiable procedure, but total pancreatectomy should be used only when all other measures have failed.

Gastric resection combined with vagotomy has been recommended in the treatment of recurrent relapsing pancreatitis. The object of the procedure is to diminish pancreatic secretion.

SUMMARY

Acute pancreatitis may be secondary to biliary-tract disease since the latter is associated with pancreatitis in many cases. Alcoholism is associated with a considerable number of pancreatic lesions.

The clinical importance of acute pancreatitis is out of proportion to its frequency because it must always be considered in the differential diagnosis of acute upper abdominal disease. The serum amylase estimation is more important than any other laboratory procedure in the investigation of these patients.

If the diagnosis can be definitely established it would appear that a conservative regime should be followed. Early and vigorous supportive treatment is effective and essential as part of this conservative regime. After the initial shock has been treated it is obvious that it would be far more serious to overlook a perforated or gangrenous viscus than to perform laparotomy in a case of acute pancreatitis. If operation reveals an acute pancreatitis, cholecystectomy, or choledochotomy if common duct obstruction is present, should be performed with as little manipulation as possible. In the absence of biliary tract disease the rationale of biliary tract drainage is open to question.

Definitive operations are required for the treatment of abscesses. The latter will increase in frequency as the more severe cases of acute pancreatitis survive the initial attack.

When pancreatitis and cholecystic disease occur together the elimination of the gall-bladder disease very frequently prevents further attacks of pancreatic disease.

It would appear that recurrent attacks of pancreatitis are frequently associated with some form of obstruction to the active secretory flow of the pancreas. The case histories presented serve to illustrate the variety of lesions which may produce recurrent pancreatitis.

It is our opinion that it is unwise to depend on any one procedure to treat all patients. We must attempt accurately to establish the aetiological factors present and select the operative procedure indicated in the individual patient.

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Year Book

ADHESIONS AND CICATRICAL STENOSES

See also B.S.P., Vol. 1, p. 72, S. Key 9.

Duodenum

Obstruction distal to ampulla of Vater

Symptoms and treatment.—GRAY and GARRETT (1955) have reviewed 68 cases in which duodenal obstruction occurred distal to the ampulla of Vater. Many of these cases had undergone previous operations for their symptoms without being relieved. The commonest symptoms were abdominal pain and vomiting. In a considerable proportion the symptoms resembled those arising from gall-bladder disease. In 34 cases the obstruction was due to a growth; in 13 it was due to pressure of the superior mesenteric vessels. Of these 13, 9 had experienced vomiting, and many stated that they were much improved while the stomach was empty. Duodenojejunostomy was performed in 37 of the series, including all the cases with obstruction due to the mesenteric vessels. Of these 13, 11 had complete relief, 1 has only been followed for a month, and 1 appears to be hypochondriacal. One case was outstanding in that pre-operative x-rays demonstrated the site of the obstruction, and revealed that the duodenum was enlarged to the size of the stomach. The authors point out that many cases of post-operative obstruction are not recognized until the majority of normal. They were explored, and for particularly of the performed.

Gray, H. K., and Garrett, C. M., Jr (1955). *Ann. Surg.*, 142, 532.

ADRENAL GLANDS

See also B.S.P., Vol. 1, p. 94, S. Key 12.

ACTH, cortisone and hydrocortisone in surgery

Therapeutic benefits and dangers

Need for further studies—ABBOTT, KRIEGER and LEVEY (1955) write on the therapeutic benefits and dangers associated with the use of ACTH, cortisone and hydrocortisone in surgery. In those patients who have acute or chronic adrenal insufficiency as a result of disease or surgical extirpation of the adrenal glands the use of cortisone or hydrocortisone is mandatory. This group includes patients subject to total adrenalectomy in treatment for Cushing's syndrome or in palliative treatment of metastatic carcinoma of the breast and prostate. Pituitary and adrenal suppression resulting in adrenal insufficiency is also observed

These hormones can be of value in producing dramatic remissions in cases of ulcerative colitis, haemolytic anaemia, thrombocytopenia and others when the need for surgical intervention is considered. The use of ACTH, cortisone or hydrocortisone in many patients may be of value in avoiding operation, improving the pre-operative status of certain desperately ill patients, or relieving some of the post-operative complications. The function of these hormones in the treatment of peritonitis, infection and shock is not yet clearly established. In burns and surgical shock and in patients with severe or fulminating infections adrenal cortical extract, ACTH, cortisone and hydrocortisone have been reported as of great value, however, most of these reports are based on small series of cases.

induced. The availability of cortisone and or total adrenalectomy a relatively safe treatment of patients subjected to subtotal

should be remembered that when given to surgical patients they can produce a wide variety of responses, many undesirable. More studies are needed before such compounds can be widely used for some of the conditions for which they have been advocated.

Abbott, W. E., Krieger, H., and Levey, S. (1955). *Ann. intern. Med.*, 43, 702.

Neuroblastoma in childhood

Surgical management

KOOP, KIESEWETTER and HORN (1955) give an account of the surgical management of

spinal canal. All patients who were free of metastases at operation have survived. No patient with metastases in the lymph nodes was com-
marrow films. The sur-

removal of viscera but to remove as much of the tumour as is practicable.

Koop, C. E., Kieseletter, W. B., and Horn, R. C. (1955). *Pediatrics*, 16, 652.

ANAESTHESIA—GENERAL

See also B.S.P., Vol. 1, p. 205. S. Key 26.

Induced hypothermia

Advantages and dangers

by SCURR and GRAY (1955) It is pointed out that the value in the surgical treatment of thyroid in operations on patients with aortic the hypothermic state cardiac activity and agulation time is increased. Furthermore, harmful bacterial and enzyme activity is dangerous must be considered. For instance,

dissociation curve is shifted to the left. Hypothermia may also cause bradycardia during the warming period when all experiments indicate that the anaesthesia and that the

induced with *d*-tubocurarine chloride, 30 milligrams, and thiopentone, 150-200 milligrams. Maintenance of anaesthesia is by means of nitrous oxide and oxygen. An electrode from a

which open heart operations were performed

Scurr, C. F., and Gray, T. C. (1955). *Proc. R. Soc. Med.*, 48, 1077.

Controlled hypothermia

Indications and results

Procedure described—SWAN and his colleagues (1955) have analysed the results of controlled hypothermia in 100 cases in which the technique was used as an aid to operation. The principal indication for its use was the need for a bloodless field during temporary interruption of the blood supply to or through the organ. A low temperature prolongs the time that tissues remain undamaged by ischaemia. In cyanotic heart disease, the patient may have a normal pulse and appearance at a temperature (rectal) of 30° C. The blood pressure also falls with the lower temperature, making evaluation of the patient's circulatory state difficult, and increasing the risk of post-operative haemorrhage. For safety, hyperventilation is necessary, and for open cardiac surgery, the authors consider a right auricular blood pH of over 7.5 to be desirable in order to minimize the risk of ventricular fibrillation. Fibrillation is also more likely because the hypothermia selectively depresses vagal function, and to offset this neostigmine was used intra-aortically during cardiac procedures. To prevent air embolism in such cases, the authors fill the wound with Ringer's solution and close the heart incision beneath the surface of this. To obtain hypothermia, the anaesthetized patient has a rectal thermometer inserted, and a transfusion of saline in his arm. He is then placed in a bath of cold water, shivering being stopped by relaxants. As his temperature starts to fall, ice is added to the bath, and on reaching 31° C. the anaesthetic can usually be stopped. The patient is removed from the water before the lowest temperature is reached, a fall of about two-thirds the range of that obtained during immersion being finally obtained. He then has a diathermy coil placed around his abdomen, and electrocardiographic leads or needles are affixed. During operation blood is replaced as it is lost. Before wound closure the patient is warmed by diathermy until he has an adequate blood flow and pressure. Complications of the method included 18 cases of ileus, 24 with pulmonary disorders, and 12 who developed peripheral neuritis. The average stay in hospital post-operatively was under 11 days, except for a few cases with mild heart failure and 8 who received burns during re-warming. Fourteen deaths directly related to the hypothermia occurred, 11 of these being due directly or indirectly to ventricular fibrillation. Eight patients died from unrelated causes. Of the 14 related deaths, only 3 deaths occurred in females, although about equal numbers of the two sexes were operated on. Cardiac complications varied in the ease with which they could be rectified. Cardiac standstill responded well to thoracotomy and manual compression. Of 15 with ventricular fibrillation, only 5 were considered to have died directly from this cause, although only 3 were long-term survivors, the others dying from haemorrhage or heart failure. The presence of previous myocardial disease seems to predispose to fibrillation, those with normal muscle being far less likely to fibrillate. The authors conclude that the method is of sufficient safety to warrant its further application, although more research is necessary into some aspects of the technique.

Swan, H., Virtue, R. W., Blount, S. G., and Kircher, L. T. (1955). *Ann. Surg.*, 142, 382.

Caesarean sections and vaginal deliveries

Use of thiopental

Several reports have recently advocated the use of thiopental (Pentothal) for caesarean sections and vaginal deliveries. McKECHNIE and CONVERSE (1955) report the results of an investigation to determine whether a specific placental barrier exists to thiopental to

section under spinal anaesthesia, a single dose of 350 milligrams of a 5 per cent solution of thiopental was given just before the delivery was deemed imminent and the time recorded.

ether, another Demerol 100 milligrams 2 hours prior to delivery, whilst the third infant had the umbilical cord wrapped twice round its neck. There was no correlation between the degree of depression in these infants and the concentration of thiopental in their cord blood, nor between the maternal depth of anaesthesia, foetal responsiveness and the thiopental concentration in the mixed cord and maternal blood. For vaginal deliveries, thiopental should be restricted to a single minimum dose administered during the last few minutes before delivery, whilst for caesarean section, it should be limited to the induction period.

McKechnie, F. B., and Converse, J. G. (1955). *Amer. J. Obstet. Gynec.*, 70, 639

ANGINA PECTORIS

See also B.S.P., Vol. I, p 259, S. Key 30.

Stellate ganglion block

The anatomical approach in stellate ganglion block is discussed by WALLS (1955). Study of the anatomy of the stellate ganglion shows that the sympathetic trunk lies deeply in the neck, and that an anterior or lateral approach must pass close to important structures in the root of the neck, the plane of the brachial plexus, the subclavian, or inferior thyroid vessels, or, particularly in the posterior approach to the

fewest serious complications, but the posterior route may be more satisfactory when much alcohol is to be injected, or when the block includes thoracic ganglia lower than the stellate.

Walls, W. K. J. (1955). *Brit. J. Anaesth.*, 27, 616.

ARTERIES

See also B.S.P., Vol. 1, p 327, S. Key 37.

Aneurysm of abdominal aorta

Surgical treatment

Rob, C. (1955). *Ann. R. Coll. Surg. Engl.*, 17, 30.

Ruptured aortic aneurysm

Surgical treatment

Five cases described.—SHUMACKER and KING (1955) discuss the surgical treatment of ruptured aortic aneurysm. Five cases are reported. The first, a man of 70 years of age, in whom a large abdominal aortic aneurysm had previously been reinforced, presented with violent abdominal pain and circulatory collapse. The perforated aneurysm was excised. No

and grafting produced excellent results. Operation on the third patient revealed large aneurysms of the abdominal aorta and right iliac artery, the latter being completely thrombosed. A graft was inserted and good circulation was maintained in the left leg, but death from uraemia supervened. In the fourth patient, operation and recovery were successful.

maximum importance. Although internal wiring and other procedures are undoubtedly palliative, they cannot prevent rupture and, even where leakage is slight, immediate surgery is indicated.

Shumacker, H. B., Jr., and King, H. (1955). *Arch Surg, Chicago*, 71, 768.

Aneurysm of the renal artery

Removal without nephrectomy

PITKANEN (1955) describes a case of a man of 43 years operated on for a suspected tumour of the kidney, which afterwards proved to be an aneurysm of the renal artery.

right rib due to trauma from which the aneurysm had resulted. The most conclusive evidence of true aneurysm was the histological structure of the tumour wall, which was identical with that of arterial wall.

pain experienced in the patient's side when walking. This assumption was also supported by the pre-hydronephrotic condition of the right kidney demonstrated by all the roentgen examinations.

Pitkanen, A. (1955). *Acta chir. scand.*, 110, 232.

Aortic embolism

Treatment by embolectomy

Basu and Das (1956) report a case of aortic embolism. The patient was a middle-aged man who had been well until 5½ hours after the occurrence, the abdomen was opened and an embolectomy performed through an incision at the umbilicus.

returned to the right foot, but there was still residual weakness of the dorsiflexors and evertors. Lumbar sympathectomy might have obviated the development of the deep venous thrombosis if the patient's condition had allowed.

Basu, A. K., and Das, A. (1956) *Brit Heart J*, 18, 126

Aneurysm of right axillary artery

Ligation of third part of subclavian artery—collateral circulation

ATKINS and JOSEPH (1955) review the collateral circulation following ligation of the third part of the subclavian artery. Fergusson and Joseph (1955) report a case of aneurysm of the right axillary artery.

uncontrollable axillary haemorrhage occurred. The third part of the right subclavian was ligated. Nineteen years later, the patient died from oesophageal carcinoma. On dissection, the axillary artery appeared normal in size. The first branch, which was additional, passed upwards to anastomose with the scapular vessels. The superior thoracic and acromio-thoracic arteries were enlarged, taking part in a thoracic anastomosis. The subclavian artery, of normal size, ended blindly deep to the scalenus anticus; from it, a vessel passed upwards and laterally, the lower of its two large branches traversing the posterior cord of the brachial plexus and joining the axillary artery on its posterior aspect. Several branches of the sub-

Atkins, H. J. B., and Joseph, J. (1955). *Guy's Hosp. Rep.*, 104, 380

Renal arteriography

Dangers

failed in both legs, so open insertion of the cannula was performed on the right leg, using 70 per cent Umbradil as the injection mass. Four hours later the patient went into shock, which responded to a transfusion, but which left the patient with signs of arterial occlusion in the right leg. There being no response to spasmolytics, sympathetic block was advised. During the early stages of general anaesthesia for a femoral thrombus was present. The kidney

Landelius, E (1955) *Acta chir scand.*, 109, 469.

ARTHRITIS—SURGICAL CONSIDERATIONS

See also II S.P., Vol 1, p 371, S Key 38.

Osteochondritis dissecans

Following ankle injuries

Necessity for x-ray of talus—Osteochondritis dissecans has been described in many joints, particularly the weight-bearing joints, but has rarely been reported in the talus. DeGINDER particularly the weight-bearing joints, but has rarely been reported in the talus. DeGINDER there was a quiet and at this time he earned out a a further 9 cases until severe joint is developed the damage had occurred Every case with an original mark removal of the necrotic chip of bone underlying the cartilaginous

DeGinder, W. L. (1955) *Radiology*, 65, 590.

Arthrodesis of the hips

Avoidance of post-operative complications

incidence of pseudo- (1956) says that r, for the shaft acts as a lever on the head at a great inclination movement of the

this leverage, the author
the hip. After a Smith-
ge iliac cortical graft in
e pubic ramus, and the

case has the desired position not been maintained by the single hip spica. The author concludes that the method has a higher incidence of successful union than those not employing osteotomy, and has allowed much earlier ambulation

Thompson, F. R. (1956) *J. Bone Jt. Surg.*, 38A, 13.

AUTONOMIC NERVOUS SYSTEMS: ARTERIES

See also II S.P., Vol 1, p. 466, S Key 45.

Posterior upper thoracic sympathectomy

Improved method of approach

Difficulties encountered—An improved approach for posterior upper thoracic sympathectomy is described by MACKEY (1955). He notes that in several methods of approach it is inevitable that the large upper back muscles have to be divided and separated and that much rib and an entire transverse process also need removal. Difficulties also occur in dealing with intercostal muscles and fascia, the pleura and the intercostal neurovascular bundles. The writer considered the advantages of a more direct approach by a limited upper dorsal costotransversectomy made possible by a midline exposure as for laminectomy.

ganglion or the second or third dorsal ganglion

MacKay, H. J (1955) *J Amer med. Ass.*, 159, 1261.

BLADDER—TUMOURS

See also B S.P., Vol 2, p. 140, S Key 58

Carcinoma of the urachus

Case report

Wright, H B, and McFarlane, D. J (1955). *Amer. J. Surg.*, 90, 693.

Wright, H B, and McFarlane, D. J (1955). *Amer. J. Surg.*, 90, 693.

Treatment

Cobalt-bomb radiation

A preliminary report on the
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PART III—ABSTRACTS

The great advantage of cobalt-bomb radiation is that only 2 gamma rays are emanated, these are of almost identical wave lengths, so that there is not the scatter which occurs with a powerful x-ray unit with a broad spectrum of emanation. As the maximum effect of the rays is about 6 millimetres below the skin, reactions were negligible. The series comprised 45 men and 13 women, aged 39–88 years; the duration of symptoms varied from 1–60 months; the tumours were transitional-cell in 33 cases, papillary in 11, squamous-cell in 8, and anaplastic in 6. A series of 34 patients were given palliative therapy, 5,000–6,000 roentgens in 3–4 weeks, and 24 received radical therapy. The author makes the following recommendations: results were encouraging in both groups. The author makes the following recommendations: irradiation should not be earlier than 3 weeks after bladder opening to expose or biopsy the tumour; the urine should be examined at least twice weekly during therapy; and attempts should be made to reduce necrotic tissue and clear up the urine with antibiotics.

Busby, S. M. (1955). *Canad. med. Ass. J.*, 73, 872.

Reimplantation of ureter

BURNS (1955) reports a case of reconstruction of the lower ureter by a tube made from bladder flaps. Damage to the ureter commonly follows radical pelvic surgery in women. The earliest use of the bladder in pelvic reconstruction was described by Boari (1894) in an operation on a dog. The latest ureteroplasty (Higgins, 1953) ingeniously preserves the ureteral orifice but is applicable only to unilateral lesions. The author presents an involved repair in a case of advanced damage to both kidneys. A married woman aged 30 years had a 4-months history of erosion of the cervix. Biopsy revealed a squamous-cell carcinoma. Intravaginal cone therapy preceded the Wertheim operation. A month later, she had nausea, vomiting, and pain in the left lower quadrant. Urology revealed a large, palpable cystic mass on the left side of the pelvis, extending above the symphysis. Cystoscopy showed 200 millilitres of residual urine and a mass pushing the bladder medially. The author suspected complete obstruction of the left ureter and a large collection of extraperitoneal urine in the pelvis. A milder obstruction was apparent on the right side. Laparotomy revealed a large cavity containing 200 millilitres of clear, straw-coloured urine lateral to the bladder. The ureter was necrotic or obstructed as far as the uretero-vesical orifice. Exposed at the point of obstruction it was 1 centimetre in size and reasonably dilated. A 7-centimetre gap remained between the viable end and the nearest portion of the bladder. To bridge this, a tapering tongue of bladder was brought up to form a tube into which the end of the ureter was laid, fish-mouthed and sutured. The broad tongue was approximated after insertion of a drainage tube. Two weeks later, urological investigation was satisfactory. Catheterization of the right ureter recovered 45 millilitres of urine; a pyelogram showed angulation and dilatation. The patient was discharged but 5 weeks later a small mass was felt in the right pelvis; on readmission it was hard and larger. Excretory urography showed complete ureteral obstruction at the pelvic brim; of the ureteral orifice. Operation revealed complete ureteral obstruction at the pelvic brim; above this, it was dilated and tortuous; below, semi-necrotic and gangrenous. A similar surgical procedure was carried out on the right side, but 12–15 centimetres of ureter had to be replaced. After 3 months, the urine was clear and the mass had completely disappeared.

Burns, R. A. (1955). *J. Urol.*, 74, 348.

Infiltrating carcinoma

Treatment

Nylon tube sutures containing radioactive cobalt.—VERMOOTEN and MAXFIELD (1955) describe the treatment of infiltrating carcinoma of the bladder by means of nylon tube sutures containing radioactive cobalt. The treatment is indicated when it is difficult to remove the growth completely. With reference to the technique, a lead-shielded container is employed in order to protect the operating team against irradiation. The sutures should be placed in parallel rows at intervals of 1 centimetre so that the tumour is irradiated from edge to edge. Large tumours are reduced in size by means of a high-frequency cutting loop until the combined thickness of the carcinoma and bladder wall measures less than 1 centimetre. Thus the needle with the nylon suture can be passed through the tumour and the invading cells become exposed to the maximal intensity of radiation. An indwelling catheter is inserted with a balloon attached to it. The balloon can be inflated in order to keep the normal bladder deflated of the balloon may give rise to radiation cystitis. Furthermore, the gamma radiation is used repeatedly, for it has a half life of 5½ years. The radioactive material can be homogeneous and most of the beta radiation is filtered by the nylon. After the appropriate dosage has been delivered the patient is given sodium penicillin and the sutures are removed. As there is little ionization of the tissues a soft flexible scar results.

Vermooten, V., and Maxfield, J. G. S. (1955). *J. Urol.*, 74, 767.

BONES—NEW GROWTHS

See also B & P., Vol 2, p. 298, S. Key 69.

Incidence of malignant cells in bone-marrow aspirations

Primary source

BERKHEISER (1955) reports the incidence of malignant cells in 246 routine consecutive bone-marrow aspirations performed in 241 patients mainly for the diagnosis of various types of anaemia. Malignant cells were demonstrated in both bone-marrow smears and

malignant cells, but in the carcinoma of the colon, sections of marrow-clot showed well-formed acini and glandular structures which were not apparent in the cover-slip preparations. In 5 of the cases (prostate, stomach and bronchus), it was only possible to state that

skeletal system before extensive surgery is attempted

Berkheiser, E. W. (1955) *Cancer, N Y*, 8, 958.

Osteogenic sarcoma

Incidence, sites, spread and treatment

Series of cases reviewed—CADE (1955) discusses osteogenic sarcoma, the only malignant tumour derived from bone or bone-forming tissue, and histologically correlated to the spindle-shaped-cell unit. The stroma may contain giant cells, fibrous tissue, cartilage or, rarely, blood vessels. The presence of cartilage has led to a clinical distinction between primary and secondary chondrosarcoma, the latter developing in a long-standing benign growth and occurring in older patients. Malignant growth in or near bone produced widely different x-ray appearances. This relentless disease, however, shows great similarity in age, incidence, primary sites, mode of spread and usually fatal issue. It occurs more often in

intramedullary spread is important in assessing amputation level. Pulmonary metastases are usual. Small, spherical, x-ray shadows at first, they increase in number and size with

traumatic "fibrositis" is unwarrantable. X-ray confirmation by "Codman's triangle", "sun-ray spicules", "onion-peel" layers of new bone must not be awaited; biopsy should not be delayed. Treatment has long been amputation, or occasionally, misguided local

many cases, and a few were spared amputation

Cade, Stanford (1955). *J.R. Coll. Surg. Edinb.*, 1, 79.

Benign giant-cell tumour of femur

Metastasis to lungs

GREGORY and WRIGHT (1955) record a case of benign giant-cell tumour of bone, which, 8 years after it had been first recognized, became malignant and metastasized to the lungs.

characteristics of a malignant giant-cell tumour of bone, Grade III in Jaffe's classification. Amputation was performed, following deep x-ray radiation; 18 days post-operatively the patient developed signs of infarction, but improved clinically. On re-admission, 3 years later, metastasis to the lungs had developed, and death occurred several months later. Examination of the pulmonary metastases showed that they were anaplastic giant-cell tumours similar histologically to the primary malignant neoplasm of the femur; they did not resemble osteogenic sarcoma. Possible causes of the malignant transformation of the tumour are thought to be inherent malignant tendency, lack of attempt to remove the neoplasm when it was first discovered, and the effect of irradiation.

Gregory, A. R., and Wright, A. W. (1955), *N. Y. St. J. Med.*, 55, 3269.

Liposarcoma in the femur

Case report

DAWSON (1955) writes on liposarcoma of bone and describes the case of a woman aged 45, first examined 11 months after first examination and

fat-positive tumour tissue inside the bone where the structure was frankly lipomatous, though showing considerable pleomorphism and mitotic activity, the whitish appearance of the prog. the presence of fat-cell characters, all pointed to criterion of sarcoma cell. Examination pointed to a primary tumour of the femur. No other distant primary growth could be found before operation; the possibility of a primary tumour being unobserved while producing advanced secondary femoral deposits seems unlikely. Both the history and the histology pointed to the view that the femur was the genetic focus. The carcinogenic factor some part in general, but here the

blood-borne stimulus to neoplasia, can be admitted; rarity of bone liposarcomas without throwing any light on their carcinogenesis.

Dawson, Edith K. (1955) *J. Path. Bact.*, 70, 513.

BRAIN—ABSCCESS

See also B.S.P., Vol. 2, p. 323, S. Key 71.

Otitic origin

Treatment by otological approach

LITTEL (1955) describes a case of brain abscess of otitic origin in a girl aged 8 years treated successfully by the otological approach and states that with precautionary

1 centimetre in diameter, was electrocoagulated and drained with a small incision made in the centre. An aspirating needle, introduced in a medial and superior direction encountered the abscess at a depth of 2.5 centimetres. Radical mastoidectomy was completed 6 weeks later and there have been no sequelae.

Littel, J. J. (1955), *Arch. Otolaryng.*, Chicago, 62, 636.

BRAIN-INJURIES AND COMPLICATIONS

See also B § P., Vol. 2, p. 349, S. Key 74.

Posterior fossa haematoma

Case reports

GROSS (1955) reports one case each of posterior fossa haematoma in the extradural space, subdural space, and in the substance of the cerebellum. Case 1, a man aged 20 years, fell from a truck and was knocked unconscious. He was found to have a slight scalp abrasion just above theinion and a bilateral positive Babinski. After 2 hours, he became semi-conscious but was restless. The cerebral spinal fluid was grossly bloodstained and under pressure. After some improvement during the next few hours, he suddenly became cyanotic and died. At post-mortem examination, a linear fracture from above theinion to the foramen magnum, a large extradural clot over the right cerebellar hemisphere and pole of the right occipital lobe, and a tear in the right lateral sinus were found. Case 2, a woman aged 51 years, was admitted to hospital complaining of back and lower extremity pain of 4 months' duration, and occipital headache and staggering to the left of 4 weeks' duration. Early papilloedema and nystagmus on left lateral gaze were present. At operation, a chronic subdural haematoma was removed from over the right cerebellar hemisphere with subsequent alleviation of her symptoms. Case 3, a man complained of home, he coll. size of a golf patient shower

of posterior fossa haematomas will increase as the awareness of their occurrence increases.

Gross, S. W. (1955) *J Mt Sinai Hosp*, 22, 286.

Head injury

Delayed complications

SEZDİMİR (1955) describes six cases of carotid thrombosis and hemiplegia occurring as a delayed complication of head injury. Analysis of the cases suggested that thrombosis of the internal artery took place as a result of trauma to the intracranial segment, and in the two cases examined after death a fracture of the floor of the anterior fossa was found in close proximity. In all cases the main impact was frontal. In the clinical progress of some head injuries a patient, after a lucid interval, may show deterioration in the conscious level, accompanied by the onset of focal signs. Exploration for massive intracranial haemorrhage may prove negative. The diagnosis made may be one of post-traumatic apoplexy or thrombosis of the middle cerebral artery or one of its branches, particularly if the patient is elderly. The commonest site of internal carotid thrombosis is suggested to be at the junction of the

carotid thrombosis.

Sedzimir, C B (1955) *J. Neurol. Psychiat*, 18, 293

Extradural haemorrhage

Mortality rate

Measures for reduction—SCHNEIDER and TYTUS (1955) recommend that a number of measures should be adopted in order to reduce the high mortality rate in patients with

massive haemorrhage. One consideration must be given to the possibility that a supratentorial haemorrhage may extend into the posterior fossa. Moreover, a head injury may produce an associated lesion such as subdural haematoma, and an extradural haemorrhage

PART III—ABSTRACTS

may be due not only to injury but also to erosion of a blood vessel by otological or rhinological infections. Operative problems may influence the mortality rate. For example, if adequate exposure is not obtained with sufficient rapidity it may be difficult to identify the origin of the haemorrhage. As for the findings during the course of the operation, if the brain tends to bulge on opening the dura further trephine holes should be made for evidence of associated lesions.

Schneider, R. C., and Tytus, J. S. (1955). *Ann. Surg.*, 142, 938.

BRAIN—VASCULAR ANOMALIES

See also B.S.P., Vol. 2.

Aneurysm

Intracranial aneurysm

Treatment.—WHEELER (1955) describes a case of intracranial aneurysm in a woman aged 53 years. The patient complained of severe headache and blindness in the left eye. Angiography revealed a large aneurysm of the left internal carotid artery. Ligation of the left common carotid artery was carried out and two months later a similar operation was performed upon the left internal carotid artery. Although recovery took place loss of vision persisted in the left eye. Employment of angiography in a series of 104 cases of intracranial aneurysm led to 4 fatalities. The aneurysm was revealed in only 79 cases. With regard to the management of aneurysm of the supraclinoid portion of the internal carotid artery Wheeler recommends ligation of the carotid vessels in the neck, but a direct intracranial operation should be performed when the aneurysm is situated more peripherally. The direct approach was adopted in 31 of 117 cases and there were 6 deaths in this group of patients.

Wheeler, J. R. (1955). *Proc. R. Soc. Med.*, 48, 1039

BREAST—CARCINOMA OF

See also B.S.P., Vol. 2, p. 456, S. Key 77.

Methods of spread

Cell migration, vascular dissemination and transplantation at operation

PRICE (1955) reviews the spread of mammary cancer. Cancer probably begins in some minute localized spot, a nest of cells, a single cell or, possibly, multicentrically. Generation occupies only a few hours, until millions of cells form a solid mass. This tumour grows rapidly along the lines of least resistance, the "open trail" being the lymphatics. Tumour cells migrate, breed, excrete, and reproduce. They work their way through delicate endothelium or capillary walls, in the lumen of which they are swept along by blood or lymph to reach a permanent lodging. The main lymphatic trunks provide roots to the axilla, mediastinum and abdomen. Reaching the nodes by afferent vessels, they invade or destroy them, emerging by efferent channels to seek new fields of conquest. Another method of spread is by the blood stream. Boyd (1953) stated that tumour emboli are not metastases, but experience shows that they can, and do, become malignant. Cancer cells, unfortunately, are also accidentally transplanted at operation. Only the surgeon can see the gross spread of the disease; its utmost limits lie even beyond the vision of the pathologist. Early diagnosis and complete excision may effect cure, but in advanced cases even radical operation is unavailing. That classical mastectomy offers only 70 per cent 5-year "cure" in carcinoma limited to the mammary gland and only 30 per cent when axillary metastases are demonstrable, that more radical give better results than less radical operations; that patients without axillary metastases have a better prognosis than those with them; that results are improved by meticulous dissection, is all understandable when the impalpable spread of the disease is realized. "Ultra-radical" surgery and radiation have their limitations and Haagensen's and Stout's criteria of inoperability take on fresh significance.

Price, P. B. (1955). *J. Amer. med. Ass.*, 159, 1345.

BRONCHIECTASIS

See also B.S.P., Vol. 2, p. 501, S. Key 81

Treatment

Resection

Results of operation.—CHESTERMAN (1955) records the results of resection for bronchiectasis in a consecutive series comprising 245 cases and 273 resections. The incidence of

collapse was only 40 per cent, not an aetiological feature in the majority of cases. Lobectomy and segmental resection in suitably selected unilateral cases gave a satisfactory result in 85 per cent, and there should be no operative mortality in this group. Pneumonectomy is associated with definite mortality and morbidity, but the satisfactory result was 75 per cent. Several pneumonectomy cases have had children without difficulty during pregnancy and parturition. About half the lobectomy cases suffer from "chestiness" in the last 3 months but improve on delivery. As regards subsequent respiratory infections there is an impression

is unlikely, provided two major functioning lobes are left intact, or unless the patient indulges in strenuous exercise.

Chesterman, J. T. (1955) *Brit J. Tuberc.*, 49, 280.

BURNS AND SCALDS

See also B 5 P., Vol. 2, p. 519, S. Key 82.

Burns

Amino-acid loss in urine

amino acid and the "total" amino acid were measured, and the amount of each amino acid in the "bound" form was determined by the difference between the two values. The results showed that the amounts of free and bound forms of the amino acids are greater in the period immediately after the burn than in the later period of convalescence. considerable

acids, and none were absent when the hydrolysed urines were tested. The results tend to indicate that the severity of the burn is closely related to the degree of the amino-acid loss in the urine.

Eades, C. H., Jnr, Pollack, R. L., and Hardy, J. D. (1955). *J. clin. Invest.*, 34, 1756

COLITIS

See also B 5 P., Vol. 3, p. 88, S. Key 97.

Ulcerative colitis

Results of biopsy of the rectum

above the anal sphincter. An anaesthetic was only once needed in the removal of 180 specimens from 150 patients. These persons were in various phases of ulcerative colitis and as a control, specimens were removed from normal bowel in patients being treated for

occasional argentaffin cell occurs. a reticular basement membrane and desquamates the surviving cells of first cuboidal and then flattened and the many basophil dividing cells in the lower parts of

the crypts of Lieberkühn evidently replace the superficial cells. In the repair of the surgical trauma inflicted in their experiments the writers found that adjacent folds of mucosa tended to fall over the bare area covered by granulation tissue and soon after flattened cells grew out from adjacent crypts. In the absence of secondary infection the diameter of the crypts soon after operation was covered in 11 days. In ulcerative colitis the sections removed 119 showed signs of activity and 48 were quiescent. The early active lesion seems to develop in the bases of the crypts where the basal cells stain most intensely.

Surgical treatment

Operative

of ulcers

24 adult

this disease were caecostomy, appendicostomy and colostomy, but these methods were not uniformly successful. In 1917 Brown proposed an end ileostomy of the faecal stream, averaging about 20 per cent and rectum had to be removed.

functions. In the remaining 8 patients, ileostomy combined with total colectomy plus

surviving patients have been rehabilitated, the exception being the patient most recently operated upon who is still convalescing. Revision of the ileostomy has been necessary in 8 patients because of ileostomy dysfunction and 2 others have developed annoying prolapses.

Nickel, W. F., Jr (1955) *Surg. Gynec. Obstet.*, 101, 353.

Segmental colitis

Signs and symptoms, treatment

MANNING, W.

intestinal haemorrhage occurred in 50 per cent; obstructive symptoms, similar to those of carcinoma, in 1 month. In 6 patients, produced only temporary improvement. Operations included 23 ileocolostomies, with resection of the diseased bowel, 10 without resection and 1 segmental resection of the descending colon with colocolostomy. After an average of 4.6 years, 19 patients were

The overall rate of arrest
ent ileostomy was success-

Manning, J. H., Warren, R., and Adl, A. S. (1955). *New Engl. J. Med.*, 252, 850.

COLON—CARCINOMA OF

See also B.S.P., Vol. 3, p. 103, S. Key 98.

Polyps of the colon

Incidence and treatment

Series of cases reviewed—The majority of cancers of the colon, if not all, arise from
With the aid of adequate data it is possible to locate and eradicate

One patient died of carcinomatosis three years after operation, but none of the remainder
has shown any signs of a recurrence

Smith, D. W. (1955) *Amer. J. Surg.*, 90, 870

COLON—DEVELOPMENTAL ABNORMALITIES AND MEGACOLON

See also B.S.P., Vol. 3, p. 130, S. Key 991.

Megacolon and associated bladder dysfunction

Elimination as a post-operative complication

The relation of megacolon and megalo-ureter is discussed by SWENSON and FISHER (1955).
A study of patients before and after operation for Hirschsprung's disease revealed that some
had defects of bladder function. To eliminate this as a post-operative complication, studies

bladder dysfunction and dilatation of the upper urinary tract, investigation of these cases
excluded obstruction at the bladder neck or uretero-vesical junction. An analysis of 60 cases
of megalo-ureter showed that the cause was a parasympathetic bladder in 30, defect in ureteral
peristalsis in 15, cord bladder in 7, and mechanical obstruction in 8 (ureterocele 4, posterior
urethral valves 3, anomaly of perineum 1) those with congenitally aperistaltic ureters were
found difficult to manage, as the disease is progressive with gradual destruction of all renal
tissue. Treatment consists of bladder-neck resection, with control of urinary tract infection,
patients are taught to empty the bladder completely. As the autonomic nerves enter the
bladder at the uretero-vesical junction, dissection in this area should be avoided.

Swenson, O., and Fisher, J. H. (1955) *New Engl. J. Med.*, 253, 1147.

Radiological investigation

grams and cystograms failed to disclose any abnormal action of the bladder. In another

revealed on pyelography and an atonic bladder without ureteral reflux was demonstrated by

urography. If the ureteral orifice is dilated, no evidence of outlet obstruction is present. If the ureteral orifice is not dilated, the outlet resistance is increased. If the amount of residual urine is large or if the upper part of the urinary tract is dilated, Resection of the neck of the bladder reduces the outlet resistance. Sometimes prolonged antibiotic therapy is of value, but sympathectomy yields disappointing results. Direct drainage of the kidney is indicated if dilatation of the renal pelvis is progressive.

Allen, R. P. (1955) *Radiology*, 65, 325.

ELEPHANTIASIS

See also B.S.P., Vol. 3, p. 362, S. Key 125.

Post-operative lymph fistula

Three case reports

PARKS (1955) describes three cases of lymph fistula in the lower limb, complicating operations or incised wounds. The term "fistula", though not accurate, is used because of its descriptive aptness. The clinical course was similar in each patient. Following a clean operation, the wound healed after a period of between 7 and 11 days. The flow of lymph was a clean, clear, straw-colored fluid.

ococci, but the wound showed no signs of inflammation. Operative intervention in this patient allowed the organisms to spread and cause acute cellulitis. Infection in the wound was rapidly followed by closure of the fistula. Treatment in lymph fistula should be conservative in the first place, directed towards decreasing the lymphatic return from the limb.

ENDOMETRIOSIS

See also B.S.P., Vol. 3, p. 387, S. Key 130.

Pathogenesis

Implantation—induction theory

As the embryonic and Sampson's implantation theories on the pathogenesis of endometriosis do not provide a fully adequate explanation for all forms of endometriosis, Levander put forward an induction theory. According to this, specific substances may be liberated from the endometrium in the uterus and transported by the lymph and blood streams, subsequently inactivating an omnipotent blastema, newly formed in the organism, into endometriosis. The purpose of a critical examination was designed to show whether endometriosis is more common than endometrium from rabbits in the last 24 hours immediately after treatment in a laboratory preparation was the centre of a space filled with the implant and the surrounding thickness in the endometrium was usually present on the first day of implantation of immature fibroblasts, but there was no progressive degeneration necrotic. In the inner-

psule In the treated implants, no endometrial cells were seen on the first day after implantation, but a marked cellular reaction was present in the lymph space and capsular membrane. There was no contact between the implant and this cellular reaction. By the third day, a rich vascularization had begun in the capsular blastema, but no vessels were evident in the lymph space or implant. By the fourth day signs of an atypical epithelium were observed on the implant, whilst in the capsular blastema a few small cysts were forming, and by the seventh day, large numbers of cysts in different stages of development were

ndometriosis

Levander, G., and Normann, P. (1955). *Acta obstet. gynec. scand.*, 34, 366.

ENDOSCOPY—BRONCHOSCOPY

See also B.S.P., Vol. 3, p. 392, S. Key 131.

Foreign bodies in bronchi

Incidence and treatment

When asphyxia or fatality is imminent. Successful extraction and complete recovery are possible in most cases; many of the complications and sequelae are the result of late diagnosis. Post-operative radiography should be performed in all cases.

Maloney, W. H. (1955) *Amer. J. Surg.*, 90, 453.

EYE—THERAPEUTICS OF

See also B.S.P., Vol. 3, p. 493, S. Key 143.

Treatment of eye emergencies

STALLARD (1955) describes the emergency treatment of certain eye conditions. Free

and a pad and bandage are applied. In cases of acute congestive glaucoma eserine sulphate, 1 per cent, is instilled repeatedly until the intra-ocular pressure reaches physiological limits. Pain is relieved by applying heat and injecting morphine. A patient with occlusion of the central retinal artery requires inhalation of amyl nitrite and a retro-ocular injection of acetylcholine, but for thrombosis of the central retinal vein no immediate treatment is likely to be of any value. For total retinal detachment atropine drops are instilled and both

eyes are occluded. If the detachment originates in the upper half of the fundus the patient should be sent to hospital in a recumbent position and if the detachment is in the lower half of the fundus the patient should be allowed to sit up.

Stallard, H. B. (1955). *Brit. med. J.*, 2, 1441.

FISTULA IN ANO

See also B.S.P., Vol. 4, p. 102, S. Key 154.

Ano-rectal fistula

Aetiology and surgical treatment

BUNNEY (1955) discusses the aetiology and surgical treatment of ano-rectal fistula. These fistulae begin as an infection of an anal gland at or near the posterior midline, the duct of which perforates the circular and longitudinal muscles. The infection extends superiorly between the longitudinal muscle and the external sphincter to form an abscess above the ano-rectal line in the supralevator space, after which it perforates the rectum. It seldom if ever penetrates into the pelvi-rectal or retro-rectal spaces. Operation is best begun by inserting a probe through the external opening in the skin and laying the tract open in stages until the midline is reached. All sphincter muscle overlying the extensions of the tract into the anal canal is then incised, but the fibrous base of the fistula is left intact. The fistulous opening into the rectum must be replaced by healthy mucosa and the ano-rectal ring left intact. This can be accomplished by using the technique described by Gant in the treatment of rectovaginal fistula. If correctly planned, this operation results in little deformity or loss of control.

Bunney, G (1955). *Amer. J. Surg.*, 90, 863.

FRACTURES, DISLOCATIONS, FRACTURE-DISLOCATIONS AND ALLIED INJURIES

See also B.S.P., Vol. 4, p. 165, S. Key 157.

Patella

Recurrent dislocation

Operative cure—HARRISON (1955) presents the long-term results of an operation for the cure of recurrent dislocation of the patella. The lateral patellar retinaculum and vastus

Four of the cases were under the age of 13 years, and developed genu recurvatum. The results were better by re-implant the tubercle less the many different methods results with those of others, but feels that the over-all results obtained by the technique is very favourable.

Harrison, M. M. (1955) *J. Bone Jt. Surg.*, 37B, 559.

Fractured calcaneus

Treatment

Necessity for functional restoration—There have been a great number of methods proposed for the anatomical restoration of a fractured calcaneus, so many that the necessity for functional restoration has perhaps been obscured. BARNARD and ODIGARD (1955) have considered the soft tissue injuries accompanying this injury, and have evolved a therapeutic function, with its not in maximum under the heel is the period of not are avoided.

from narrowing of the osseo-ligamentous tunnel for the peronei. The authors have treated 22 fractures in this manner, the average period of disability in 19 of these being 13.7 weeks. The period for the others was prolonged by associated injuries. The authors consider that these results are encouraging, and that such a regime will greatly reduce the number of cases requiring subtalar arthrodesis.

Barnard, L., and Odegard, J. K. (1955). *J. Bone Jt. Surg.*, 37A, 1231.

Ankle

Acute inversion sprains

Follow-up of cases.—Acute inversion sprains of the ankle with tearing of the lateral ligament are usually treated in a manner which ensures the most rapid return to work. Prolonged follow-up of such cases is uncommon, unless there is some marked residual

symptoms following acute ankle sprains.

Bosien, W. R., Staples, O. S., and Russell, S. W. (1955). *J. Bone Jt. Surg.*, 37A, 1237.

Hip

Recurrent dislocation

Case history.—Frequently recurring dislocation of the hip is rarely seen, and has only been recorded in 7 cases. SULLIVAN, BICKEL and LIPSCOMB (1955) report a case of a male aged 60 years who had a right amputation of the leg for carcinoma of the foot. Three years later he sustained posterior dislocation of the left hip from a fall, which was reduced, the patient making a good recovery. In the next 3 years the hip dislocated 3 times, and 4 years later it dislocated 3 times in 1 year. Accordingly, the joint was explored, the gluteus minimus was torn longitudinally over the posterior aspect of the capsule, there being a corresponding rent in the capsule itself. A buttress of iliac bone was screwed on to the upper posterior margin of the acetabulum, the tears in muscle and capsule repaired, and the wound closed. Post-operatively, good progress was made and almost normal hip function obtained.

Sullivan, C. R., Bickel, W. H., and Lipscomb, P. R. (1955). *J. Bone Jt. Surg.*, 37A, 1266.

Shoulder

Recurrent dislocation

bony
delto-
capsul
humer

intact it is stapled on to the shaft. The degree of immobilization depends on the integrity of the bone structure of the upper end of the femoral shaft. The nail is usually firmly grasped by the dense trabeculae of the femoral head, but the trabeculae at the upper end of the shaft are more loosely arranged, and in some parts of the neck are absent. The distal fragment in such cases is held only by the cortex, which in the aged may be extremely thin, so that considerable movement in the

Du Toit, G. T., and Roux, D. (1956). *J. Bone Jt. Surg.*, 38A, 1.

Femoral neck

Non-union after displaced intracapsular fractures

There have been many suggested explanations of the frequent occurrence of non-union after displaced intracapsular fractures.

and blood supply to the head is poor. When a straight nail is employed for internal fixation, the degree of immobilization depends on the integrity of the bone structure of the upper end of the femoral shaft. The nail is usually firmly grasped by the dense trabeculae of the femoral head, but the trabeculae at the upper end of the shaft are more loosely arranged, and in some parts of the neck are absent. The distal fragment in such cases is held only by the cortex, which in the aged may be extremely thin, so that considerable movement in the

cases required re-nailing several weeks after the primary operation as the original nail became disengaged from the head; successful union followed. These were the only 2 cases to whom a plaster cast was applied. In 5 cases the nail protruded through the femoral head, but the protrusion was sufficient to warrant removal of the nail in only 3 of these. Some degree of aseptic necrosis occurred in 4 patients. Although the series is small, the use of a combined nail and plate has been shown to be a safe procedure, and, by virtue of the improved immobilization accompanying its use, appears to increase the likelihood of bony union.

Eaton, G. O. (1956). *J. Bone Jt. Surg.*, 38A, 23.

Displacement osteotomy

In a 20-year period, WARDLE (1955) has performed displacement osteotomy of the upper end of the femur on 69 patients suffering from ununited fractures of the femoral neck, or unreduced congenital dislocation or osteoarthritis of the hip joint. After oblique subtrochanteric osteotomy, the lower fragment was immobilized at such an angle of abduction that, when united and the leg adducted into a weight-bearing upright position, the upper fragment would be in the position of maximum adduction. Only if this position is obtained can the best result be expected. Where the correct angle has been achieved in the author's series, the joint space in some cases has reappeared, and ununited neck fractures have healed. Forty of the cases have been followed for 10 to 20 years. Thirty-one were enthusiastic about the result, and 10 as poor as when they first came to the hospital. The author concludes that this type of operation should continue to be given serious consideration.

Wardle, E. N. (1955). *J. Bone Jt. Surg.*, 37B, 568.

GALL-BLADDER AND BILE PASSAGES

See also B.S.P., Vol. 4, p. 238, S. Key 161.

Methods of examination

Intravenous cholecystangiography

Study of 100 cases.—A study of 100 cases in which the biliary tract was examined by intravenous cholecystangiography is presented by BATT (1955). The new method, in which a chemical compound named Cholografin is used, has made it possible to demonstrate the bile-ducts radiologically even although the gall-bladder is absent or abnormal. Its greatest advantage is in studying the patient who has had cholecystectomy, but it has also been valuable in cases of gall-bladder disease in which the ordinary Graham test has been

griping, dysuria, and urticaria.

Batt, H. C. (1955). *Radiology*, 65, 926.

Intravenous cholecysto-cholangiography

In
bil
vis
from gastro-intestinal dysfunction or to gall-bladder disease. In known cases of allergy or with strong positive tests prior to administration, premedication with Benadryl is recommended. Warmed to body temperature, 40 millilitres of Cholografin is injected slowly for 10 minutes

bladder is seen in from 10 minutes to 2½ hours after injection and, once filled, its examination is completed as after oral cholecystography. In the presence of obstructive jaundice, the ducts cannot be visualized. Normal hepatic and common bile-ducts measure 5–6 centimetre in diameter, the cystic duct 0.2–0.3 centimetre. Any departure from these measurements is abnormal and may reveal duct calculus, stricture, stenosis of the sphincter of Oddi, intrinsic tumour or extrinsic pressure. Results suggest that compensatory dilatation of the main ducts does not follow cholecystectomy but, in the absence of calculi, adhesions or tumours, is usually caused by stricture of the duct or stenosis of the sphincter of Oddi. The so-called post-cholecystectomy syndrome then is probably a late recognition of conditions existing before operation, whether or not the gall-bladder was diseased at this time. Cholangiography has shown the most frequent cause of dilatation of the extrahepatic duct to be stenosis of the sphincter of Oddi. It has also revealed important anatomic variations, residual cystic duct stumps and "reformed" gall-bladders.

Shehadi, W. H. (1955). *J. Amer. med. Ass.*, 159, 1350.

Biliary tract and pancreatic surgery

HALLENBECK and his associates (1955) present a report on biliary tract and pancreatic surgery for 1954. Among 65 patients with acute cholecystitis, cholecystectomy revealed gall-bladder calculi in 59; 7 patients also underwent exploratory choledochostomy and stones were recovered from the common ducts of 6. Cholecystostomy was done in the remaining 6 cases. Of 1,036 patients operated on for chronic cholecystitis, 93 per cent had gallstones. Cholecystectomy alone was done in 769 cases, in 246 it was combined with common duct

the common or hepatic ducts, various anastomoses were performed. Section of the sphincter of Oddi was done in 35 cases, 21 being pancreatitis. Seven pancreatic pseudocysts were treated. Carcinoma of the pancreas occurred in 76 cases, in 34, only exploration was possible. The Whipple operation was successfully performed in 7. The mortality rate of 1.4 per cent resulted chiefly from cardiac, vascular and renal complications.

Hallenbeck, G. A., Walters, W., Gray, H. K., Priestley, J. T., and Waugh, J. M. (1955) *Proc. Mayo Clin.*, 30, 640.

Biliary-tract disease

Diagnosis and treatment

ZOLLINGER, BOLES and CRAWFORD (1955) review the diagnosis and treatment of biliary-tract disease. Complications include common-duct calculi, acute cholecystitis and pancreatitis. Cholecystography is highly accurate, but a single examination with non-visualization is inadequate. The positive demonstration of stones indicates operation, but poor filling,

the cases as having calculus obstruction. In the authors' technique, the distal end of the common duct is preserved.

Stock, F. E., and Tinckler, L. F. (1955). *Surg. Gynec. Obstet.*, **101**, 599.

Cholelithiasis

Cholecystectomy

Persistence or recurrence of symptoms—In 10-15 per cent of patients with cholelithiasis treated by cholecystectomy, symptoms persist or recur. Although these usually appear to be due to some condition other than cholelithiasis which was not recognized or properly evaluated prior to cholecystectomy, quite often they are due to an incomplete operation in which stones or a remnant of the gall-bladder or cystic duct has been left behind. GLENN and JOHNSON (1955) review 35 cases of cystic duct remnant seen during a 22-year period at the New York Hospital—Cornell Medical Centre. An additional 148 cases from the literature are also reviewed. The average age of the patients was 52 years and females outnumbered males by 3.4 to 1. The symptoms of the cystic-duct remnant were identical with those of gall-bladder disease, but pain was more severe and jaundice occurred in 19 although a common-duct stone could not be demonstrated in 7 of these. Rigors and fever occurred in 20 per cent and 3 patients had a biliary fistula. There was a lag interval between the cholecystectomy and the recurrence of symptoms averaging 3.8 years. One patient was asymptomatic.

common duct were found in several. Stones were found in the cystic-duct remnant in 10 cases and common-duct stones in half of the 26 choledochotomies performed. A gall-bladder remnant was found in 9 cases, 3 of which contained stones. Changes of acute or chronic inflammation were present in all but 3 of the 24 cystic-duct remnants examined. Perforation of the remnant had occurred in one case. There were 3 deaths in this series. Of the 27 cases adequately followed up, 19 consider themselves well, 5 still have minor complaints, whilst 3 have had to undergo further surgery, stones being found in the common duct in 2 and a persistent cystic-duct remnant in the other. An appreciation of the anatomical variations of the cystic duct in relation to the common duct and greater attention to technique by the surgeon should decrease the incidence of cystic-duct remnants.

Glenn, F., and Johnson, G., Jr. (1955) *Surg. Gynec. Obstet.*, **101**, 331.

Neoplasms of gall-bladder and bile-ducts

Study of 113 cases

Extra-hepatic biliary-duct cancer is discussed by GLENN and HILL (1955). A study has

artery, the common duct, and the associated portal vein down to the duodenum. In carcinoma of the extra-hepatic bile-ducts, radical procedures are less applicable than in other groups, palliative procedures, including local resection for distal common-duct lesions, have been the most satisfactory. Since the introduction of radical pancreaticoduodenectomy, the

the diagnostic and surgical approaches available at present; extension of survival and palliation have been the experience of the authors in these cases, radical surgery aimed at cure should be used further, although the operative mortality has been high.

Glenn, F., and Hill, M. R., Jr. (1955) *Cancer, N.Y.*, **8**, 1218.

GASTRO-COLIC FISTULA

See also B.S.P., Vol. 4, p. 272, S. Key 164.

Gastrojejunalocolic fistula

Clinical picture and treatment

Gastrojejunalocolic fistula is discussed by RHIND (1955) who describes 5 cases which differed very much from the usual picture of this condition. The first had had posterior gastroenterostomy for duodenal ulcer in 1938 and had *not* been comfortable thereafter, being seen again in hospital in 1952. He had had pain and vomiting at about 3-month intervals and been away from work several months each year. Bowel action was normal and weight maintained. A barium enema showed a gastrojejunalocolic fistula and at operation the anastomosis and fistula were separated and the parts repaired before a high partial gastrectomy was done. Recovery was uneventful. Another patient had been treated for duodenal ulcer by partial gastrectomy and retrocolic anastomosis but a month later developed a gastrojejunal ulcer which responded to medical care. A year later pain recurred with diarrhoea and foul eructations but no vomiting. Medical measures again gave some relief but a barium meal showed a large ulcer in the jejunum near the stoma. A year later he perforated near the anastomosis and at operation the colon was separated with difficulty and the holes were closed. He was well 2 years later. Before the last intervention he had had a transthoracic vagotomy which was followed by a tendency to diarrhoea. The other of the 5 cases were of similar nature. The writer notes that in addition to these he has performed gastrectomy for 23 other cases with anastomotic ulcer so that fistulae occurred in about 15 per cent of his total. Some suggest that intermittent symptoms in fistula are rare but in the last of his 5 cases the writer recorded long intermissions of pain and he pleads that mild cases should be suspected and thus recognized in the absence of the supposedly severe and persisting symptoms.

Rhind, J. A. (1955). *Lancet*, 2, 1225.

GENITAL ORGANS—FEMALE EXTERNAL

See also B.S.P., Vol. 4, p. 289, S. Key 166.

Vulva

Carcinoma

The treatment of carcinoma of the vulva is discussed by EASTON and his colleagues. They report 100 cases recorded at the Middlesex Hospital, London. The average age of the patients was 62 years. 4 per cent of the number of cases of genital tract cancer. Unexpectedly good results were obtained with simple vulvectomy, but many cases were of relatively low malignancy. When the lymphatic glands were affected by the disease the prognosis was extremely grave. Most patients who died within 5 years showed invasion of the lymphatic glands.

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Easton, A. L. T., Andrews, P. S., Way, S., and CHAPMAN, A. (1955). *Proc. R. Soc. Med.*, 48, 1091.

GUNSHOT WOUNDS AND ALLIED INJURIES
(GENERAL MANAGEMENT)

See also B.S.P., Vol. 4, p. 352, S. Key 174.

Thorax and abdomen

Pre-operative and operative treatment

GRATTAN (1955) discusses the management of gunshot and sword wounds of the thorax and abdomen. The discussion has special reference to the treatment of 46 Africans;

there were 10 fatalities in this series of cases. Conservative treatment is indicated in the management of haemothorax due to through-and-through gunshot wounds. Aspiration of the chest does not increase the risk of precipitating further haemorrhage. Infection is combated with penicillin injections, and streptokinase-streptodornase is injected in cases of clotted haemothorax. Thoracotomy should be employed if 2-3 pints of blood are withdrawn

out local excision. As for penetrating wounds of the abdomen, haemostasis is a primary requirement. Auto-transfusion is a useful measure even when the blood is found to be grossly contaminated. Exteriorization of the injured colon is required only when the degree of bruising or viability is in doubt and when resection is precluded owing to the patient's condition. In a patient with thoraco-abdominal injuries the abdominal injury should be given priority so far as surgical intervention is concerned.

Grattan, E (1955). *Brit. J. Surg.*, 43, 279

HAND

See also *II S P.*, Vol 4, p 386, *II Key* 178

Major infections of the hand

Diagnosis and treatment

FLYNN (1955) reviews major hand infections, namely lymphangitis, deep-fascial-space abscess, and acute suppurative tenosynovitis. Diagnosis and treatment depend upon knowledge of the an abrasion or w Red streaks exten history of deep in of the entire hand and forearm. In both, there is voluntary and painless movement of the fingers, no pain on hyperextension, no tenderness over the tendon sheaths, no palmar bulging and no tenderness over the mid-palmar and thenar spaces. Its incidence is 15-25 per cent less than before antibiotic therapy. Treatment includes warm sterile saline dressings, immobilization, fluids and penicillin, 100,000 units, 4-hourly. Complications, although greatly diminished since the advent of antibiotics, include sloughing of connective tissue, nodal abscesses, subpectoral abscess and pus under the pectoral and subscapular muscles. These must be incised and drained. The humoral chain of axillary nodes emptying into the

injection of penicillin the case
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Flynn, J. E (1955). *New Engl. J. Med.*, 252, 605.

Dupuytren's contracture

Incidence, aetiology and predisposing causes

Survey of 5,000 patients—YOST, WINTERS and FETT (1955) describe a survey in which more than 5,000 patients were examined for evidence of Dupuytren's contracture. The deformity was observed in 120 males and 51 females, and the average age of these patients was 68 years. As compared with the findings in previous surveys the condition was found in a relatively large number of women. Few Negroes showed signs of the deformity. One man stated that his father had also suffered from it. The left and

in approximately equal numbers, and contraction of the ring from

Trauma was not considered a specific injury associated with the disease. It was felt that a predisposition to large-handedness and a correlation was present. The use of smaller hand tools. No cases. Pain was not a common complaint. A few patients complained of the contracture and no patient wished to have it corrected by means of surgical treatment.

Yost, J., Winters, T., and Fett, H. C., Sr. (1955). *Amer. J. Surg.*, 90, 568.

HERNIA

See also B.S.P., Vol. 4, p. 428, S. Key 180.

Inguinal herniorrhaphy

Criticism of procedures

Inguinal herniorrhaphy is described by DORAN (1955) who remarks that the usual procedures are being more severely criticized every day. Success depends as a rule on establishing adequate union between the conjoint tendon and Poupart's or Cooper's ligament. But any tissues sewn together under tension easily separate and even 50 years ago some of the current methods were suspect. By inserting radio-opaque markers into the tissues to be joined together it has been possible to demonstrate their separation within a few months. The

and the anterior superior spine. Arising from this point the conjoint tendon of the internal oblique aponeurosis maintains the integrity of the inguinal canal. It arises from the outer part of the aponeurotic sheet which for in such a way as to overcome the resistance to tearing the 'internal oblique' muscle or the conjoint tendon protects the canal arising from without this the absence of these muscle units which ex-

operation.

Doran, F. S. A. (1955). *Lancet*, 2, 1307.

Problems in the treatment

The treatment of hernia. The trans- which at the deep inguinal n, filmy layer; frequently by the inferior epigastric vessels, a true fascial margin is absent. The conjoint muscles help to maintain the integrity of the canal, if we believe that this control can be regained, the muscles may be left as functioning units, otherwise there is inevitably some fibrous tissue replacement of their

always be considered as the most effective safeguard against recurrence. In the repair of

Farquharson, E. L. (1955) *Ann. R. Coll. Surg. Engl.*, 17, 386

Retromesocolic hernia

Case report

SMITH (1955) describes a case in which a retromesocolic hernia developed to the right of the middle colic artery. The hernia occurred in a girl, aged 5 years, with generalized

exception, because the retromesocolic hernia usually lies to the left of the middle colic artery.

Smith, C. C. K. (1955). *Brit. med. J.*, 2, 1487.

INFECTION, INFECTIONS AND INFLAMMATION

See also B.S.P., Vol. 5, p. 86, S. Key 192

Cortisone

Use in suppressing inflammatory reactions

Mechanism of suppression—Cortisone in sufficiently large doses is known to suppress inflammatory reactions, but the mechanism of suppression is not understood. ALLISON, SMITH and WOOD (1955) have studied the effect of cortisone on standard inflammatory lesions produced by thermal injury to the rabbit ear. They found that the period of initial peripheral ischaemia was prolonged, and that as the circulation was restored, there was a long delay before the appearance of vasodilatation. The degree of dilatation was very small even after a considerable period. Permanent occlusion of the vessels in the injured area occurred as in untreated animals. Refractile globular bodies can be seen in lesions produced in rabbits not given cortisone, and their production was unaffected by the drug. Rouleaux formation occurred early, being rapidly followed by the normal vascular stasis. Oedema formation and haemorrhage were much less than in untreated animals. Appreciable leucocyte sticking was usually delayed for up to 3 hours, and did not reach the intensity or extent that can be seen in untreated specimens. Within 6 to 9 hours after injury the sticking began to regress, and after 24 hours was only occurring at isolated spots on the periphery of the

which initiate inflammation

Allison, F., Smith, M. R., and Wood, W. B. (1955). *J. exp. Med.*, 102, 669.

INTESTINES

See also B.S.P., Vol. 5, p. 121, S. Key 195.

Benign tumours of the small intestine

Series of 22 cases

SHANDALOW (1955) discusses benign tumours of the small intestine, relatively infrequent usually asymptomatic and often incidental. In this series of 22, encountered in 2,648

result in necrosis and malignant degeneration. Lipoma is a rare, yellowish, soft, sessile, non-invasive mass sometimes causing intussusception. True fibroma is rare; when extraluminal, it may be the size of an adult head. Neurofibroma probably originates along the autonomic fibres. Single or multiple, sessile or pedunculated, large or small, it occasionally causes intussusception. It is frequent in the small intestine, especially in the ileum. It may be associated with skin naevus or to melanoma of the retina or rectum; it may, however, be primary and melanoblastic in origin. The complications of haemorrhage, obstruction, intussusception, ulceration and malignant degeneration should first be distinguished, by barium x-ray or surgery. Treatment is simple excision. Uncomplicated cases, however,

Shandalow, S. L. (1955). *Arch. Surg. Chicago*, 71, 761.

Malignant argentaffinoma of the small intestine

Two case reports

JENKINS and BUTCHER (1955) discuss two cases of malignant argentaffinoma, the association of which with cyanosis and pulmonary stenosis was already known. The first patient seen, a woman of 63, had complained for 18 months of intermittent lassitude with watery diarrhoea, in the last year of which there was a period of high dyspnoea and of the type of a supposed When

of the caecum and metastases were seen in adjacent lymph nodes and in the liver identified as those of an argentaffinoma. In the second case complaint of dyspnoea and intermittent diarrhoea for 2 years was made by a woman of 59. Four months before admission she had

failure was made and treatment was designed 8 weeks later. The autopsy findings were pulmonary stenosis was evident, also tricuspid incompetence. The primary growth was in the ileum.

Jenkins, J. S., and Butcher, P. J. A. (1955). *Lancet*, 1, 331.

Primary mesenteric venous thrombosis

Symptoms and treatment

laparotomy, a large quantity of serosanguinous fluid was found in the peritoneal cavity. Mesenteric thrombosis involved the upper 2 feet of jejunum. Resection and end-to-end jejunojejunostomy were performed. The lumen contained blood.

The pathology and microscopic appearances were identical in every case. In Cases 2 and 3 there was a history of thrombophlebitis of the legs, an implication regarded by North and Wollenman (1952) as important.

Bussey, C. D. (1955). *Arch. Surg., Chicago*, 71, 658.

Congenital atresia below the duodenum**Operative mortality**

Review of literature and 10 cases.—GERRISH (1955) has reviewed the literature on congenital intestinal atresia below the duodenum, and presents the findings in 10 further cases. Increased awareness of the condition has led to a decrease in the immediate operative mortality, as the infants come to surgery in much better general condition. Later deaths have been due to the difficulty in such young patients of maintaining an adequate nutrition and electrolyte balance. Some have also died through breakdown of the intestinal anastomosis. To overcome these difficulties the author uses end-to-end anastomosis after resection

from a relieving operation. Two other deaths occurred, 1 from failure to decompress the proximal loop, and 1 due to massive necrosis from a pre-operative volvulus. The author concludes that his method is easier to perform than exteriorization, does not require a secondary operation, and avoids the necessity for a long period of supportive therapy, with its attendant dangers of electrolyte imbalance in an infant.

Gerrish, E. W. (1955) *Ann Surg*, 142, 469.

INTUSSUSCEPTION

See also B.S.P., Vol. 5, p. 160, S. Key 200.

Recurrent ileocolic intussusception**Associated with hypertrophy of Peyer's patches**

Surgical treatment.—SARASON and his associates (1955) describe a case of recurrent ileocolic intussusception associated with hypertrophy of Peyer's patches. The patient, a male infant, was first operated on for an ileocolic intussusception at the age of 4 months. No intrinsic abnormality of the terminal ileum was observed. Surgical reduction of a

metres of the terminal ileum were definitely thickened and an ileocaecal resection was performed. Gross examination of the resected specimen revealed 2 mucosal thickenings completely encircling the bowel lumen, 1 of which involved the ileal surface of the ileocaecal valve, whilst between the thickenings there were 4 shallow ulcers in the mucosa. The thicken-

Sarason, E. L., Prior, J. T., and Prowda, R. L. (1955) *New Engl. J. Med*, 253, 905.

JAUNDICE

See also B.S.P., Vol. 5, p. 176, S. Key 198.

Obstructive jaundice**Clinical diagnosis**

BRUCE (1955) discusses the clinical diagnosis of obstructive jaundice. Although early differentiation into "surgical" and "medical" jaundice is often easy, many baffling cases

is easily recognized; in atypical cases a permanent

certain evidence of extrahepatic obstruction and almost certainly malignant

Bruce, J., C.B.E. (1955). *J.R. Coll. Surg., Edinb.*, 1, 149.

Diagnostic procedures

GRAY and RINSLER (1955) discuss diagnostic procedures in obstructive jaundice. Four simple tests are essential and usually sufficient to confirm the diagnosis, establish the cause and indicate secondary liver damage. These tests are:

is not; it may, however, occur in jaundice and bile passages after bacterial infection. Serum bilirubin and its estimation is essential in suspected haemolysis, as in this condition the bilirubin is elevated, the condition is more severe than in obstructive jaundice, but combination of the two conditions is not infrequently encountered.

Gray, C. H., and Rinsler, M. G. (1955). *J.R. Coll. Surg., Edinb.*, 1, 159.

Decompression of hepatic duct system

STRAUSS and his colleagues (1955) discuss surgical decompression of the hepatic duct system in chronic jaundice resulting from acute and subacute hepatitis. The pathological process in hepatitis involves the liver and entire ductal system; the ducts, in cases of longstanding jaundice, become greatly dilated and exude quantities of bile and pus when opened. Clinically, 3 groups of patients are encountered; those with colicky attacks

Histologically, the condition resembles acute yellow atrophy. The pancreas varies in consistency; peripancreatitis causes omental adhesions and even obliteration of the lesser omental cavity. In 1 patient, a severe infiltrating duodenal ulcer near Vater's papilla caused intermittent jaundice for 10 years. Severe liver damage and coma resulted, with duodenal

recurs, the Roux Y operation is advocated. Details are given.

Strauss, A. A., Strauss, S. F., Schwartz, A. H., Tannenbaum, W. J., Kram, D. D., and Masur, W. W. (1955). *J. Amer. med. Ass.*, 159, 739.

JOINTS—TUBERCULOSIS

See also II S.P., Vol. 5, p 219, S. Key 207.

Treatment

Use of anti-tubercular drugs

Combination with arthrodesis—SMITH (1955) has considered the treatment of bone and joint tuberculosis with the aid of the new anti-tubercular drugs. Prior to the advent of surgical arthrodesis, results of joint tuberculosis were appalling, and in many cases misdiagnosis had occurred. Operative interference increased the recovery rate, and also reduced

infection was walking without support 6 months from the commencement of treatment. Where, prior to antibiotic therapy, tuberculous abscesses were never opened, most will now resolve after removal of the primary focus, and can be drained if necessary. In a further 3 cases antibiotic therapy and plaster immobilization were used to treat joint tuberculosis after arthrotomy, without arthrodesis. Two of these achieved complete cure, and in 1, a hip infection, some coxa vara ensued but the infection was completely overcome. The author concludes that the antibiotics are of great value, particularly in fulminating cases, abscesses, and sinuses, but that in most cases their use should be combined with arthrodesis. In all cases, the diagnosis should be fully established, and the follow-up continued for a long time.

Smith, A. DeF. (1955). *J. Bone Jt. Surg.*, 37A, 1214

KIDNEY AND URETER—DENERVATION OF THE KIDNEY

See also B S P, Vol. 5, p 259, S Key 209

Nephroptosis

Nephropexy

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ago, nephropexy was used commonly on very slight indications and without previous urological study, and this has resulted in the operation being brought into disrepute so that many patients are now deprived of the surgical relief that could be afforded provided true indications for operation are present. The commonest symptom of nephroptosis is pain after exertion or after standing for some time. The pain may be severe or of a dragging or aching character, sometimes confined to the loin, sometimes with an anterior or distal radiation. Even when the kidney cannot be easily palpated, a slight degree of mobility in

for 10 days and then only gentle exercise for 2 months as too early exertion may precipitate

cases interrogated 6 months to 13 years after operation results were still good or moderately good in 28 and poor in only 3

Silverton, R. J (1955). *Med J Aust*, 2, 925.

See also B.S.P., Vol. 5, p. 307, S. Key 213.

Treatment

Investigation of conservative methods

The treatment of renal tuberculosis is discussed by [] of spontaneous recoveries from renal tuberculosis [] given by streptomycin and various chemotherapeutic possibilities of treating the disease conservatively, kidneys), classified in 8 groups according to radiology showed that conservative treatment plus nephrectomy was much superior to conservative treatment alone, as regards relief of symptoms, destruction of bacilli, and fitness for work. The study [] excellent results also valuable [] papillae, of [] (groups 2-3 of the present series), recovery occurred in 29 of 31 cases; only 25 were free from tubercle bacilli, however, possibly because of activity of []

removal of a kidney with complete destruction, in the present series, give support for resection of a small focus, that is, a smaller but radical operation, although some normal renal tissue must be sacrificed; some cases suggest that prolonged conservative therapy may normalize parts of the kidney which, radiologically, seem to lack functional capacity.

Franzas, F. (1955). *Acta chir. scand.*, 110, 31.

Selective principle

SENB (1955) writes on the selective principle in the treatment of urogenital tuberculosis, partial resection of the kidney and of the ureter. Mass examination of the urine for tuberculosis has revealed that 3 to 4 per cent of patients with pulmonary tuberculosis in Norway have positive urine culture and 10 to 20 per cent of cases have bone and joint tuberculosis.

mass examination for tubercle bacilli in the urine analogous to the examinations of the sputum. In the selective medical-surgical treatment the medical treatment is principally directed against the non-destructive infiltrations of the urogenital tract. The surgical treatment aims at the removal of the active, necrotic, destructive foci of the ulcero-cavernous type, which represent the source of the disease, through selective operations with preservation of a maximum of healthy functioning tissue and not removing the non-destructive foci (infiltrations) which may heal spontaneously or by medical treatment. As regards medical treatment, sanatorium treatment combined with A+C treatment is advocated in all cases.

has proved effective in renal tuberculosis as in pulmonary tuberculosis.

Semb, C. (1955) *Urol. int.*, **1**, 359.

Chemotherapy

(1955) have compared 90 cases, with 132 patients in the control group. In the early cases received 100 per cent and 75 per cent of cases appeared to decrease conversion frequency, due to a possible decrease of renal function. The combination INH+DHS+PAS was superior to DHS+PAS. The chemotherapy cases were marked by

made for at least 3 years after completion of treatment

Halkier, E., Meyer, J., Palmlov, A., Jonsson, G., Mathusen, W., Hoeg, K., and Arnesen, A. (1955). *Acta chir. scand.*, **110**, 51.

Comparison of different preparations of PAS

and produced a high urinary concentration

Obrant, Ola (1955). *Acta tuberc. scand.*, **31**, 289.

LUNG—TUMOURS

See also *II S P.*, Vol 5, p. 450, S. Key 225.

Cytology of sputum

Koss and RICHARDSON (1955) summarize the main causes of potential diagnostic errors

in the presence of clusters of densely packed elongated cells with dark dense nuclei. Confusion between these clusters and clusters of cells of anaplastic carcinoma can be avoided if, besides all the cellular characteristics of malignant cells, consideration is given to the fact that

clusters of exfoliated cancer cells are usually arranged rather loosely, isolated single malignant cells are almost invariably present, and that the cells in the atypical bronchial clusters are

and if they do, it can be seen that they do not have the characteristics of malignant cells except for slight irregularities of the nucleus and cytoplasm. Numerous clusters of lymphocytes are present in the sputum of most cases of bronchogenic carcinoma and their presence in the absence of suspicious cells suggests that a repeat examination be performed. Macrophages, particles of acellular material, and vegetable cells may occasionally cause confusion with cancer cells.

Koss, L. G., and Richardson, H. L. (1955). *Cancer, N.Y.*, 8, 937.

Asymptomatic cancer

Surgical treatment

Potential curability.—OVERHOLT, BOUGAS and WOODS (1955) review the surgical treatment of lung cancer found on x-ray survey. Asymptomatic cancer has a higher rate of resectability and a greater potential curability than symptomatic; 46 such silent cases are presented. In 30 of these, a 3-year survival rate of 30 per cent compares favourably with 12 per cent for

shaped lesion is the common bronchus. Satellite nodules, or years, do not exclude cancer

enlarged lymph nodes or by resection of the lesion. If malignancy is found, lobectomy or pneumonectomy is performed.

Overholt, R. H., Bougas, J. A., and Woods, F. M. (1955). *New Engl. J. Med.*, 252, 429.

Relation of occupation and smoking to lung cancer

Report of study

A study of occupation and smoking among lung cancer patients at the Roswell Park Cancer Institute. The study was conducted in 1954. The control samples had an age-occupation group. Out of 18 major occupation

these occupations could not be explained by smoking. Individuals who had never smoked

effect on those in occupations not associated with lung cancer.

of an additive effect of smoking and occupation amongst cigarette smokers, but the factor of occupation did not account for the higher incidence of lung cancer amongst cigarette smokers.

Levin, M. L., Kraus, A. S., Goldberg, I. D., and Gerhardt, P. R. (1955). *Cancer*, N. Y., 8, 932.

MOUTH AND PHARYNX, MALIGNANT DISEASE OF

See also B S P, Vol. 6, p. 82, S. Key 234.

Evolution of major surgery

Relation between radiotherapy and surgery

... not only can better treated by it others may be treated by either means and

used sometimes to produce spread of a growth along the raw surfaces of extraction. The basis of operative technique is that laid down by Trotter. Gradual evolution has been made by better anaesthesia, control of infection and more understanding of the principles of plastic repair. Post-operative success is judged by the quality of breathing, swallowing, appearance and speech. Speech therapy is very useful after major mouth operations.

Gardham, A. J. (1955). *Ann. R. Coll. Surg. Engl.*, 17, 291.

MUSCLE AND TENDON—DISEASES AND INJURIES

See also B S P, Vol. 6, p. 128, S. Key 235.

Malignant tumours of skeletal muscle

Research into the histogenesis

CONSTANCE (1955) writes on research into the histogenesis of the malignant tumours

parts highly pleomorphic. Careful microscopic study of the anaplastic tumours, however, establishes their identity as fibrosarcomas, they show a variable amount of inter-cellular connective tissue, and the various transition stages between growths with a moderate amount

Constance, T. J. (1955). *J. Path. Bact.*, 70, 365.

Pigmented villo-nodular tenosynovitis*Study of operative specimens from 34 cases*

SHERRY and ANDERSON (1955) have studied the operative specimens from 34 cases of pigmented villo-nodular tenosynovitis and have compared them with a smaller series of "pigmented villonodular synovitis". The lesion has been known as a giant cell tumour of the synovium, but it consists of a cellular proliferation of the synovial lining, the cells consist of mononuclear cells, but some are multinuclear, and the stroma is cellular, but the cells are not giant cells, but are of the type of synovial cells, and scattered throughout were collections of pigment-stained macrophages. Enlargement of the tumour resulted in the formation of a fibrous capsule. Later there was gradual replacement of the cellular content by fibrous tissue, leaving nests of tumour cells. The variation in appearance of the 2 types is due to the confined space within which the lesion must develop. The lesion is probably inflammatory in origin, the inflammation being a reaction to injury.

Sherry, J. B., and Anderson, W. (1955). *J. Bone Jt. Surg.*, 37A, 1005.

NECK—CYSTIC SWELLINGS OF

See also B.S.P., Vol. 6, p. 178, S. Key 238.

Branchial cysts*Surgical treatment*

CONWAY and JEROME (1955) discuss the surgical treatment of branchial cysts and fistulas. A review has been made of 90 cases. Embryological studies demonstrate that countless possibilities for developmental errors exist, explaining to some extent the occasional unusual features of these lesions. The presence of thymic tissue within the cyst is not a feature of these lesions, rather than genetic lesions. A sinus diagnosed as a branchial cyst may be determined as a branchial cyst, but it may also be considered as a branchial cyst, or as a metastatic carcinoma.

Conway, J., and Jerome, J. (1955). *J. Bone Jt. Surg.*, 37A, 621.

NEOPLASMS—INNOCENT AND MALIGNANT

See also B.S.P., Vol. 6, p. 194, S. Key 240.

Dermoid tumours*Difficulties in diagnosis*

Extra-abdominal dermoid tumours belong to the fibromatoses, and may cause much difficulty in diagnosis. It is essential for the pathologist to examine the tissue for microscopy. In the treatment of these lesions, the presenting symptoms are to muscle but not to the skin. The ages of the patients ranged from 2 to 61 years. Six of the lesions were in the leg; they were firm, and the lesions were in the leg; they were firm.

yellowish, and lobulated, not encapsulated, and in each case they were infiltrating the surrounding muscles but with no direct invasion of bone. Microscopically they consisted of moderately cellular fibrous tissue, with typical adult fibrocytes, and rare mitotic figures. None were degenerate. At the advancing edge, most had entrapped muscle cells, which showed degenerative changes. There was never any attempt at encapsulation. The desmoids can be differentiated from sarcomas, by remembering that the latter are more cellular, have a strong tendency to encapsulate, and show numerous abnormal mitotic figures. Treatment consists of local excision, and as recurrences are no more malignant than the original tumour, they can easily be eradicated if they occur. Four of the present series had local excision without recurrence, and one had a known incomplete removal to save involved vessels, and has had no further trouble. Two had the limb amputated, one because of misdiagnosis, and the other due to vessel involvement. In the last case, a radical excision was performed, the tumour recurred after 3 years, and was re-excised. In no case was x-ray therapy used. There is evidence in the literature to suggest that progesterone may have a place in treatment in the future.

Ramsey, R. H. (1955). *J. Bone Jt Surg.*, 37A, 1012.

Multiple neurofibromatosis

Disease groups and associated lesions

VENNER (1955) described the condition of multiple neurofibromatosis. This disease has been established as of a hereditary nature, with a family history clearly apparent in many cases although it may appear sporadically. The disease groups include cutaneous and generalized multiple neurofibromatosis, plexiform neurofibroma, elephantiasis neuromatosa; solitary neurofibroma, both cutaneous and in other sites. The condition has been described as one of "neuro-ecto-dermal dysplasia" and has a similarity to tuberose sclerosis. The most

central nervous system are not common, but there is a comparatively high incidence of feeble-mindedness. Malignant tumours may occur. The treatment of the disease can only be palliative, the problems are mainly mechanical.

Venner, B (1955) *Aust. N.Z. J. Surg*, 25, 110

NERVES, PERIPHERAL—INJURIES

See also B.S.P., Vol. 6, p 218, S. Key 242.

Two-stage operation

Minimal traction injury

POLLARD and GRANTHAM (1955) describe a method of performing a 2 stage repair

to complete loss of nerve function. Any return of sensation in an anaesthetic area is useful and any motor recovery is preferable to complete loss of function. The result of

Pollard, C., Jr., and Grantham, E. G. (1955). *J. Neurosurg.*, 12, 627.

See also B.S.P., Vol. 6, p. 304, S. Key 247.

Congenital oesophageal atresia

Diagnosis

NICKS and CAUGHEY (1955) describe congenital oesophageal atresia. Untreated, the condition is fatal, but in favourable circumstances, operation recovery rates of 50-70 per

absence does not exclude it. Pre-operative preparation is essential and repeated aspiration of the pharynx must be maintained. Upon diagnosis, infusion of antibiotics should be

Nicks, R., and Caughey, R. H. (1955). *N.Z. med. J.*, 54, 682.

Regurgitant oesophageal ulcer

Symptomatology and treatment

SCHMIDT (1955) writes on regurgitant oesophageal ulcer, which mostly occurs secondarily to oesophageal hiatal hernia of the sliding type or to operations on the cardia. The oesophagus becomes short and usually strictured as a result of fibrosis in the muscular layers of the oesophagus, caused in turn by chronic oesophagitis. The symptoms include dysphagia, retro-sternal burning, epigastric pain, pyrosis, vom. findings will show the shortening of the oesophagus. The oesophago-gastric junction will be located at. If symptoms or roentgenologic findings suggest regurgitant ulceration at the oesophago-gastric junction, oesophagoscopy should always be done to identify the lesion and to rule

must be done oesophagocardiomyotomy (modified Heller) is the safest procedure. In a review of records of a group of patients over a period of 10 years it was found that 9 underwent subtotal gastric resection, 5 had excellent results, 2 good results, and 2 had poor results

Schmidt, H W (1955). *Arch. intern. Med.*, 96, 717.

Carcinoma of the oesophagus

Palliative segmental resection

It has been stated that the performance of a palliative segmental resection in carcinoma of the oesophagus with its resultant correction of the associated dysphagia is justified because recurrence of tumour at the site of the anastomosis is a rarity even in those who eventually succumb to the disease. SCANLON and his associates (1955) analyse a series of 79 cases in which a segmental resection had been performed, to determine the incidence of inadequate longitudinal resections. There were 36 cases which could be placed in a determinate positive group consisting of those in which it was possible to demonstrate microscopically that carcinoma was present in the margins of the resected surgical specimen or that recurrent tumour was present at the line of the anastomosis either in a biopsy or the autopsy specimen. Nine cases could be placed in a determinate negative group consisting of those with no evidence of carcinoma in the margins of the resected surgical specimen or of a recurrence at the line of anastomosis in the autopsy specimen, whilst 34 were placed

quality were seen scattered sparsely through a watery, pale eosin-staining, non-mucin-staining medium, which was much vacuolated. Abrupt transitions to areas of spindle-celled tumour tissue were noted, in which the cytoplasm was brightly eosinophilic. Many cells were distorted, but in others definite strap-like forms were assumed. The diameter of the striated

Sandison, A. T. (1955). *J. Path. Bact.*, **70**, 433.

PANCREAS

See also B.S.P., Vol 6, p. 433, ■ Key 257.

Pancreatic cyst

Pancreatic fistula

HILL and his colleagues (1955) discuss pancreatic ductal decompression, of which internal drainage of a pseudocyst by cystoenterostomy and cure of a chronic external fistula by its implantation into the jejunum are examples. Du Val (1954) described caudal pancreatico-

complicated by a faecal fistula. Transection of the pancreatic tail was performed with pancreaticojejunostomy to divert the pancreatic flow from the fistula. After closure of the faecal fistula the patient was discharged.

Hill, R. L., Judd, C. S., Shaw, W. R., and Boyar, W. T. (1955) *Arch Surg., Chicago*, **71**, 710.

Pancreatography

Investigation of 100 cases

Wirsung by means of a plastic tube. Radiological examination is carried out during the injection of 10 millilitres of the contrast medium. The injection must be made slowly. Dilatation of the pancreatic duct system may be revealed by means of this technique. The dilated ducts may result from recurrent pancreatitis and long-standing spasm of the sphincter

compresses the plastic tube in the duct of Wirsung and the pancreatic duct system can be filled completely. The duct of Santorini was outlined by the pancreatogram in 39 per cent of the number of cases investigated by the authors. In 1 case the pancreatogram revealed a large pseudocyst in the posterior mediastinum and the connection with the

Islet-cell tumour

Clinical features and treatment

Islet-cell tumour of the GRIMSON and YELL (1955) to the definitely malignant drunk when first seen and was sweating slightly. These changes had occurred in a series

pancreas. The gland was removed and after a post-operative period in which insulin was needed to control the high blood sugar complete recovery occurred. The patient resumed work in a coal mine having been unemployable for 2 years. The tumour was a benign islet-cell adenoma.

Grimson, T. A., and Yell, Joan (1955) *Lancet*, 1, 334.

PEPTIC ULCER AND ITS COMPLICATIONS

See also B.S.P., Vol. 6, p. 496, S Key 262.

Gastric ulcer

Post-operative occurrence of pulmonary tuberculosis

Causative factors.—ALLISON (1955) discusses 21 cases of pulmonary tuberculosis following subtotal gastrectomy. Starvation, mal-assimilation of food, metabolic imbalance and lowered resistance are the causative factors. In 17 patients, previous pulmonary tuberculosis was not evident, in 4, it had been inactive. Pre-operative anti-tuberculosis drugs reduced the mortality to 2. The interval between gastrectomy and the diagnosis of active tuberculosis ranged from 14 days to 14 years. The average 4-year interval represents the lapse of time between gastrectomy and contact with open tuberculosis, the time between infection and diagnosis or the time taken to overcome resistance. Before gastrectomy, x-ray screening is essential. Where tuberculosis is demonstrable, anti-tuberculosis drugs are indicated. After operation, 6-monthly x-ray examinations of the chest should be made for 5 years

Allison, S. T. (1955). *New Engl. J. Med.*, 252, 862.

Review of cases referred for surgery

BRAASCH, CAIN and PRIESTLEY (1955) review the records of the 50 patients who had had surgical treatment at the Mayo Clinic between 1940-46 for gastric ulcers within 2 inches of the oesophago-gastric junction. They constituted about 5 per cent of the patients operated

logical study of the lesion itself. The large majority of the ulcers were situated on or near the lesser curvature, in these cases, although a variety of surgical procedures were employed,

gastroenterostomy would appear preferable to total gastrectomy or oesophagogastricomy as a means of treatment. Three out of the 4 deaths in the series followed total gastrectomy.

Braasch, J. W., Cain, J. C., and Priestley, J. T. (1955). *Surg. Gynec. Obstet.*, 101, 280.

period of about and low-grade ns in 203 cases, 36 cases. Major disorders included duodenal fistula, stomal dysfunction, pneumonitis or atelectasis, and wound dehiscence or sepsis. A duodenal fistula developed on the fourth day in a man, aged 48 years, with a large duodenal ulcer which had penetrated deeply into the pancreas. Only 9 patients expressed dissatisfaction with the results of the operation. In evaluating the

Metcalf, P. B., Jnr., Cooper, P., and Smithwick, R. H. (1955). *Ann Surg.*, 142, 924.

PERITONEUM AND PERITONITIS

See also B S P., Vol. 6, p 544, S. Key 264.

Acute chylous peritonitis

Clinical appearances and treatment

infection. Some years before the patient had had an operation for tuberculous cervical glands. With good drainage the patient's pain ceased and convalescence was uneventful

provided a safety valve. At the second operation no sign of chylous leakage was seen so that the collateral channels had probably opened up by then.

Walker, J. C. (1956) *Lancet*, 1, 83.

PLEURA—DISEASES OF

See also B S P., Vol. 7, p 55, S. Key 270.

Chronic pleural empyema

Treatment

walls a surgical measure is necessary. With an intact and healthy lung thoracoplasty must never be contemplated.

feature in the wall of the cavity. This calls for treatment by drainage. A series of 48 patients were treated by pleural decortication in the period 1947 to 1955. The average duration of the pleuritis was over 5 years; in 6 patients it had been present for over 10 years. All had tuberculous infections. The procedures were visceral decortication in 35 cases; visceral decortication with partial pleurectomy in 13; there was associated procedure on the pleura

subsequent thoracoplasty; 1 post-operative spread, 1 dead. Forty-four of the results were satisfactory; 4 unsatisfactory. Thoracoplasty has been found a better management for patients with a secondarily infected tuberculous pleuritis who are too ill for pleuropneumotomy. A long-standing extrapleural pneumothorax, with or without a tuberculous infection of the space, represents a continuing hazard to the patient and should be closed

Kergin, F. G. (1955). *Ann. R. Coll. Surg. Engl.* 17, 271.

POLIO MYELITIS

See also B.S.P., Vol. 7, p. 94, S. Key 274.

Abductor paralysis of shoulder

Value of splinting

SHARRARD and KNOWELDEN (1956) report the results of an assessment of the value of abduction splinting, in relation to the principal aims of the splinting, in the treatment of abductor paralysis at the shoulder. Of 359 upper limbs of 230 patients, in whom some

respirator treatment had been necessary. No splinting after 6 weeks had been carried out in 86 instances in which the deltoid muscle had been less severely affected. After 18 months, irrespective of the age of the one or both limbs, recovery was found to be diminished being: Group A, 15; Group deltoid muscles graded 1 or 2 of the shoulder joint was for

and sometimes harmful.

Sharrard, W. J. W., and Knowelden, J. (1956). *Lancet*, 1, 9.

PROSTATE

See also B.S.P., Vol. 7, p. 133, S. Key 278.

Prostatic median bar

Transurethral resection

Histology.—CLARKE and LATORRACA (1956) report the results of a histological clinical study of 17 cases of prostatic median bar treated by transurethral resection. The patients' ages ranged from 21 to 78 and each exhibited typical cysto-urethroscopic evidence of

addition there was oedema of the stroma which in the severest cases proceeded to fibrosis. In no case was there significant histological evidence of an inflammatory process. These changes in the stroma are probably a result of the treatment.

Clarke, B. G., and Latorraca, R. (1956). *Arch. Path.*, 61, 37.

Carcinoma of prostate

Orchidectomy and stilboestrol therapy

GANEM (1955) evaluates the results of the treatment of carcinoma of the prostate by means of orchidectomy and stilboestrol therapy. The author bases his observations upon a study of 221 cases with particular reference to the number of patients who were alive 5 years after the initiation of treatment. It is considered that if the disease is not extensive at the time of operation and chemotherapy is given, the results are better.

Ganem, E. J. (1955) *J. Urol.*, 74, 804.

Prostatectomy

Radical retropubic

Results of operation—ATHERTON and ATHERTON (1956) report on the results obtained with radical retropubic prostatectomy in the management of 30 cases of prostatic carcinoma and 21 cases of conditions such as prostatitis. Twelve patients were alive and free from disease 22-65 months after the operation. Within this period there were 4 deaths due to carcinoma and 2 deaths due to pulmonary embolism. One patient with unsuspected tuberculous prostatitis died from miliary tuberculosis. The authors recommend the use of radical retropubic prostatectomy in the management of prostatic carcinoma.

over a gauze sponge. By means of the operation satisfactory urinary control becomes established within an average period of 1 week. Hormone therapy is not required for patients with a small area of carcinoma which is well confined within the prostatic tissue. Orchidectomy should be performed for local recurrence of the disease and when metastases occur.

Atherton, L., and Atherton, L. D. (1956) *J. Urol.*, 75, 111.

from hospital has not been encountered. Meatal stenosis following all types of prostatectomy would seem to have been more frequent recently; this may possibly be due to the use of antibiotics, but the size of the catheter used is another factor in its production. Although statistics all point to the rarity of osteitis pubis before the retropubic operation became popular, this condition is by no means limited to this operation. Its pathology remains unsolved.

Kirkland, K. (1955). *Med. J. Aust.*, 2, 921.

Suprapubic prostatectomy

Morbidity.—HARRIS (1955) discusses morbidity associated with the operation of suprapubic prostatectomy with closure. This operation is not one for the occasional prostatectomist as the details of the operation play a very great part in reducing mortality and morbidity. A nice clean intracapsular removal of the prostate is essential. In the author's hands, mortality and morbidity are now extremely low due in large measure to adequate treatment in hospital as a prelude to operative interference. Incisional hernia is rarely seen as the suprapubic incision is small, whilst the high opening in the bladder and method of closure make urinary fistula rare. Osteitis pubis has not been encountered. The positive haemostasis results in relative freedom from reactionary and secondary haemorrhage from infection. Efficient retrigonalisation is an absolute preventive to post-operative bladder neck obstruction. Post-operative obstruction has at times occurred in patients with a protuberant abdomen

to failure to remove all the obstruction. Urinary continence is the rule from the time the catheter is removed, but re-education of the bladder to increase its capacity may be necessary. Epididymitis despite vasotomy is still a worrying complication, whilst urethral stricture has been seen following trauma from catheterization.

Harris, R. G. S. (1955). *Med. J. Aust.*, 2, 917.

Transurethral resection

Morbidity.—MORTENSEN (1955) discusses morbidity following prostatectomy by transurethral resection. In a series of 950 patients with clinically benign prostatic obstruction

eliminated by vasotomy. Post-operative stricture of the urethra occurred in 7 per cent, but only the occasional case needed constant and permanent sounding. This complication, according to Carlson, may be associated with long continued use and immersion of the instruments in sterilizing solutions for long periods, as, with the purchase of a new instrument, the occurrence of strictures virtually disappears for a while. No obvious case of haemolysis has been seen in the last 500 cases. Provided obvious precautions are taken against haemolysis, the use of sterile water is preferable to isotonic solutions. In this series, no instance of permanent incontinence was seen. Post-operative infection of the urine in most cases cleared with the epithelialization of the prostatic cavity and required no active treatment. Its degree was relative to the completeness of the resection.

Mortensen, H. (1955). *Med. J. Aust.*, 2, 919.

PULMONARY TUBERCULOSIS

See also *U.S.P.*, Vol. 7, p. 197, S. Key 281.

Treatment

Segmental and wedge resection; lobectomy and pneumonectomy

BROWN, DRASH and MINOR (1956) discuss the use of segmental and wedge resection, lobectomy and pneumonectomy in the treatment of 106 patients suffering from severe pulmonary tuberculosis. The results obtained with those obtained in a series of 100 patients employed in cases of severe disease when the operation was performed on the right lung. The case fatality for Group I was 4.7 per cent.

and when the sputum is no longer infective. In these circumstances it is unnecessary to resort to treatment other than the presence of cavitation. Bronchopleural fistulas,

may improve the eventual course of the disease, especially when the residual nodules are more than 2 centimetres in diameter.

Brown, L. B., Drash, E. C., and Minor, G. R. (1956). *Amer. Rev. Tuberc.*, 73, 79.

RECTUM—BENIGN TUMOURS OF

See also B.S.P., Vol 7, p. 319, S. Key 289.

Villous tumours

Radical approach in treatment

whilst in 2 cases of malignancy with metastases, the patients were treated for palliation by desiccation and radiation. In the remaining 16 patients, 3 tumours were excised surgically after delivery through the anus, 1 which proved to be a carcinoma *in situ* was excised locally by colotomy, and the remainder were treated from below by desiccation alone after snare resection. In 11 patients, the tumours were indistinct, subserosal, and the operation was performed 11 times, but the results, all but one, were satisfactory. Provided

the adjacent mucous membrane as well as the tumour are thoroughly treated, removal from below by thermal or surgical means would appear to be an adequate method of treating low rectal papillomas which have a small base and show no invasion of the basement membrane.

Freund, N. L. (1955) *Amer. J. Surg.*, 90, 873.

SALIVARY GLANDS

See also B.S.P., Vol 7, p. 430, S. Key 298.

Parotid gland

Fatty infiltration simulating mixed tumour

A case of fatty infiltration of the parotid gland forming a nodule that could not be differentiated clinically from a mixed tumour of the parotid, is reported by Gilman,

Gilman, R. A., Schwartz, M., and Gilman, Janet S. (1956). *J. Amer. med. Ass.*, 160, 48.

Sialoangiectasis

BISGARD and KIMBALL (1955) discuss the pathology of sialoangiectasis of the parotid glands. This condition is characterized by gross cystic dilatation of the ducts and alveoli not associated with obstruction of the ducts as a result of calculi, stricture or tumour. It may, however, be associated with the presence of masses of lymphoid tissue in the gland substance, either diffuse or localized, and containing foci of epithelial cells probably originating from the parotid ducts. The histological picture may be suggestive of lymphosarcoma. The differential diagnosis is discussed and also the treatment of previously reported cases by either excision, or excision followed by irradiation. The assessment of these methods is difficult because it was not always clear whether the lympho-epithelial lesions were associated with sialoangiectasis or not. The authors report a case of bilateral sialoangiectasis in a woman aged 55 years. A right parotid swelling had been present for 7 years and a left parotid swelling for 1 year. Bilateral drainage had previously been performed. Sialograms showed bilateral cystic and saccular sialoangiectasis. Bilateral total parotidectomy with preservation of the facial nerve was carried out at two operations. The interval between the right and left parotidectomy was 3 years because of the patient's initial refusal to have a second operation. Histologically both glands showed dilated ducts and a large mass of lymphoid tissue with well developed germinal centres and dilated lymphatic channels. Several cysts between 5 and 10 millimetres in diameter were present containing clear fluid and lined by squamous epithelium.

Bisgard, J. D., and Kimball, K. (1955). *Arch. Surg., Chicago*, 71, 337.

Acute suppurative parotitis

Treatment

PULASKI and KEELING (1955) report 2 cases of acute suppurative parotitis in men, 1 following pancreatic fistula, the other, areolar wound grew on culture, *Staphylococcus aureus*, purulent discharge from the abdominal wound grew on culture, *Staphylococcus aureus*, alpha-haemolytic streptococci and *Aerobacter aerogenes*. A month later, bilateral parotitis developed. After erythromycin therapy with concurrent irradiation, the parotid swelling disappeared and the abdominal leakage ceased. In the second case, oral tetracycline was given and the abscess drained. Cultures grew coagulase-positive *Staph. aureus* sensitive to bacitracin, chloramphenicol and erythromycin. Two days after leaving hospital, a purulent bilateral parotitis developed. Aspiration and chloramphenicol instillation produced rapid improvement. Culture of the aspirates revealed *Staph. aureus*. A few days later, necrotic parotid tissue presented and was removed. Recovery was immediate and cultures were negative.

Pulaski, E. J., and Keeling, W. M. (1955). *New Engl. J. Med.*, 253, 1028.

SPINAL COLUMN

See also B.S.P., Vol. 7, p. 539, S. Key 306.

Traumatic paraplegia

Results of late laminectomy

HAGELSTAM (1955) describes the results of late laminectomy in 48 cases of traumatic paraplegia, treated since 1943. In 26 cases the cause was closed fractures of the spine and in 22 it was open war injuries. Four patients had cervical injuries, 8 had dorsal lesions, 30 were located to the thoraco-lumbar region and 6 were pure caudal. In 11 cases there was an obvious compression of the cord or cauda equina, in 17 cases there was no demonstrable result of the operation was noted. In no case was there any improvement of function—motor, sensory or bladder—management. Laminectomy has often a very good influence on the patient's psychological condition. Laminectomy should be performed at a late stage if the patient has not had the advantage of being operated on earlier. Since complete anatomical transection of the cord cannot be diagnosed clinically all traumatic spinal cord lesions should be explored as soon as possible after injury. Traumatic paraplegia always has been the indication for surgery in the author's hospital and laminectomy has long enough for the result of the operation to be judged. Only 5 of the 22 patients with open injuries and 7 of the 26 with closed injuries were observed for less than 6 months after operation.

Hagelstam, L. (1955). *Acta chir. scand.*, 110, 218.

Vertebral osteochondritis*Pathology, clinical symptoms and treatment*

cartilage and bone appear, enlarging and fusing into a flattened ring, constituting in man an apophysis rather than an epiphysis. The apophyseal bony centres first appear, about the

common ligament. Growth thus ceases in the anterior parts of the bodies, increasing the deformity due to bone destruction and increased pressure. Lumbar osteochondritis is often only revealed by radiography. The changes, occurring alone or with thoracic involvement, show extensive collapse of cartilage with a major disc protrusion separating part of the apophyseal rim. Increase in antero-posterior diameter of the affected body is diagnostic

or games in a few weeks. The lesions gradually heal and, when growth is complete, the

the incidence among country boys doing heavy farm work. A congenital and familial aetiology, put forward by Kemp and Wilson (1947), is interesting but not convincing.

Butler, R. W (1955) *Proc R Soc Med.*, 48, 895.

SPINAL CORD

See also *■* S P, Vol 7, p. 572, S Key 307.

Spinal canal*Dilatation at thoraco-lumbar junction*

Jefferson, A. (1955). *J. Neurol. Neurosurg. Psychiat.*, 18, 305

Tumours*Compression of spinal cord*

Early detection—The early detection of compression of the spinal cord by new growths is discussed by ROWBOTHAM (1955). In a period of 8 years he saw 80 such cases of which three-quarters were primary growths. An analysis was made to determine whether diagnosis might be possible without using dangerous or distressing methods of investigation. Forty-six

tumours were derived from the tissue of the spinal cord and the
36 tumours was possible only
mats and neuromats were cor

to 60 lymphatics per 100 mm. with limb weakness should excite suspicion. A negative
Queckenstedt's test does not exclude tumour and to wait for evidence of bone damage
may be disastrous. Angiomats may be clinically indistinguishable from meningiomats and
neuromats but may greatly damage the cord without causing blockage or change in the

interpreted. Spina bifida with signs of compression suggest embryoma. Root pain is a common
sign of growth arising in the posterior walls of the body cavities and operation for these can
rarely be more than palliative.

Rowbotham, G. F. (1955). *Lancet*, 2, 1220.

SPLEEN—SURGERY OF

See also B.S.P., Vol. 8, p. 1, S. Key 308.

Splenectomy

Indications and results

COLLER (1955) discusses the spleen and some of its diseases that may be treated by surgery.
A study has been made of a series of patients treated by splenectomy during the period
1934-55. The results have
surgeons in defining the ir

primary hypersplenism; these
52 of congenital haemolytic
anaemia, 1 of primary splenic neutropenia (without arthritic manifestations), and 2 of
splenic pancytopenia. The
comprising 32 congestive
disease and 1 of infectio
of idiopathic acquired h
anaemia. The operation
comprising 3 cases of splenomegaly of undetermined aetiology, 2 of cyst, 2 of sarcoidosis
and 6 of miscellaneous conditions. An analysis of the results shows that surgical measures
are most
syndrome
may be
spleen, it
advised.

cytopenic purpura and acquired haemolytic anaemia, the drugs appear to be equally effective
when given in doses of 100 milligrams of ACTH or 300 milligrams of cortisone daily. The
use of steroid therapy may obviate the need for splenectomy in selected cases. These drugs
have little to offer in cases of congenital haemolytic anaemia, as splenectomy is so specific
in this disease, they may, however, occasionally be of value in controlling haemolytic crisis
or in the preparation of patients for subsequent operation. Other points of special importance
in pre-operative preparation, in addition to the usual general measures, include: adequate
blood volume, appropriate antibiotics, especially in cases of splenic neutropenia, pan-
cytopenia, or Felty's syndrome, gastro-duodenal intubation; use of the proper anaesthetic.
An analysis of the author's cases showed an excellent clinical response in 71.5 per cent;
total failure (immediate or early death without improvement) in 17.9 per cent; 10.6 per cent
of the patients survived the operation but derived little or no benefit from splenectomy.

Coller, F. A. (1955). *Ann. R. Coll. Surg. Engl.*, 17, 335.

Rupture of the spleen

Radiological diagnosis and treatment

PAYNE (1955) describes a case of splenic rupture in a woman aged 55 years. The patient
gave a history of falling against a settee. The accident was forgotten after a few days of pain
in the left side and difficulty in breathing. During a routine examination 14 days later it

performed and the ruptured spleen was removed. The spleen was found to be surrounded by a large haematoma. There was no evidence of either splenic disease or serological abnormality.

Payne, W. J. (1955) *Brit. med. J.*, 2, 1370

STOMACH—DISEASES OF

See also B.S.P., Vol. 8, p. 49, S. Key 312.

Partial gastrectomy

Complications

The complications of partial gastrectomy are discussed by STAMMERS (1955). The author stresses the paramount importance of pre-operative physiological balance; post-operative balance is even more important, and it is therefore assumed that every patient, either in the theatre or immediately on return to the ward, is placed on gastric suction (Ryle's tube),

down and become a reservoir for bile and pancreatic juices, preventing them from being admixed with food and so causing steatorrhoea.

Stammers, F. A. R. (1955) *Ann. R. Coll. Surg. Engl.*, 17, 373.

Benign gastric tumours

Diagnosis

Benign gastric tumours are rare, and usually only seen at autopsy, they may present difficulties of diagnosis during life. LUND (1955) records 10 such cases of ages from 36 to

In 4 the bleeding was massive, 2 had palpable swellings, and all were diagnosed as carcinomas. At operation the tumours were all at a distance from the curvatures of the stomach, and were up to 8 centimetres in diameter. Three of the cases had a gastrectomy, in 2 the tumour only was removed. There was 1 operative death, the other 4 being well after at least 2 years.

Lund, R. (1955). *Acta chir. scand.*, 109, 407.

SUBPHRENIC ABSCESS

See also B.S.P., Vol. 8, p. 104, S. Key 314

Spread of infection to chest

Study of series

HARLEY (1955) discusses subphrenic abscess with particular reference to the spread of

types of abscesses showed 171 intraperitoneal, 14 extraperitoneal, 2 combined and 1 unknown. The evidence indicates that the movement of peritoneal fluid; gravity, when the patient is recumbent, and hydrostatic pressure when he is upright. Once infected fluid reaches any part of the diaphragm it is likely to spread over its surface by the constant movement occurring between the diaphragm and its related viscera. No evidence was found to suggest that spread of infection with the abdominal lymphatic pathway spaces, especially the infection across the such as rupture of the abscess, or a per lymphatic spread in the conduction of infection to the chest. Serous pleural effusions result from the out-pouring of an inflammatory, but non-infective, exudate caused by dilatation of the minute vessels under the diaphragmatic pleura. They have a different mode of origin and should not be considered as harbingers of tuberculosis. In the 188 patients; of the 60 on whom the procedure was considered to have been caused by the procedure.

Harley, H. R. S. (1955) *Ann. R. Coll. Surg. Engl.* 17, 201.

TESTICLE AND TUNICA VAGINALIS

See also B.S.P., Vol. 8, p. 174, S. Key 320

Epididymitis

Combined therapy

FLORENCE (1956) states that the management of epididymitis consists in rest, elevation of the scrotum and the administration of analgesics and antipyretics. At first cold should be applied to the affected area.

biotic therapy with cortisone therapy. Florence describes 5 cases in which combined therapy proved to be successful. For example, a man aged 23 years with acute epididymitis was given routine treatment as well as cortisone, penicillin, streptomycin and achromycin. Complete recovery was effected in 6 weeks.

Florence, T. J. (1956). *J. Urol.*, 75, 133.

Imperfect descent

Passage of testicle into a superficial inguinal pouch

MACNAB (1955) describes maldescent of the testicle. Recognition of a superficial inguinal pouch acting as an abdominal portion of the scrotum (Browne, 1933) has revolutionized treatment. The testicle, emerging from the external abdominal ring, may pass down into the scrotum proper or turn upwards and outwards to occupy this abdominal extension, believed to be a developmental remnant of a mechanism providing the low-temperature environment essential for spermatogenesis. Testosterone, the internal secretion of the testicle, is responsible for the secondary sexual characteristics of puberty, but does not activate spermatogenesis. This stimulus originates in the anterior lobe of the pituitary, where 2 forms of gonadotrophins have been isolated. The testicle begins to develop at the sixth week of intra-uterine life and rapidly descends to the inner aspect of the internal abdominal ring, where it remains until the seventh month, reaching the scrotum during the eighth month. A palpable testicle must lie in the normal or in the "primitive" scrotum, the so-called ectopic testicle lying in the latter. The only true ectopic form arises when the testicle occupies the superior inguinal pouch, constituting a barrier to de lateral and cannot be palpated. Testicles can be massaged into a normal position by the fourth year. In this series of 350 cases, 75 per cent were palpable in the superficial inguinal pouch and in 95 per cent could just be massaged over the symphysis pubis. Operation should be reserved for cases where this manoeuvre cannot be achieved by the age of puberty or where the testicle is impalpable. Increasing knowledge in assessing

fertility by examining the seminal fluid seems to justify exploratory operation at the age of 12 years, with a view to bilateral orchidopexy. The presence of a hernial sac, however, is a complication. In this series, 43 were treated by concurrent herniotomy and orchidopexy, irrespectively of age. Torsion and pain in undescended testicle are rare. It is, however, highly sensitive and liable to trauma, particularly at games. Hormonal therapy, 4 intra-

Macnab, G. H. (1955) *J. R. Coll. Surg. Edinb.*, 1, 126.

THROMBOSIS AND EMBOLISM

See also II S.P., Vol. 8, p. 234, S. Key 324.

Thrombosis in malignant disease

In pancreatic adenocarcinoma, bronchial carcinoma and ovarian teratoma

brain, kidneys and spleen, and terminal thrombosis of deep veins of right calf with pulmonary embolism. The second case had an anaplastic squamous carcinoma of bronchus with a solitary metastasis in the pons, fibrin vegetations on mitral and aortic valves, with embolism and infarction of myocardium, spleen, kidneys, pituitary, liver and skin. In the third case there was a malignant ovarian teratoma, with secondary deposits in liver, abdominal lymph nodes and 1 adrenal, thrombotic vegetations on mitral valve, with old and recent infarcts in

thrombotic vegetations occasionally found in such states it does not explain their formation early in the primary disease, before infection or cachexia are prominent, nor indicate why that that anti-

Smith, J. P., and Yates, P. O. (1955) *J. Path. Bact.*, 70, 111

THYROID GLAND—DISEASES OF

See also B II P., Vol. 8, p. 256, S. Key 257.

Malignant tumours

Relationship of lymphosarcoma and Hashimoto disease

Examination showed unilateral or bilateral enlargement of the thyroid gland, the swelling was usually firm and some cases showed fixation of the gland. Operation revealed adhesions, and invasion of surrounding tissues. Cervical lymph-node metastases were found in 4 cases and distant metastases in 4 cases. Treatment consisted of subtotal thyroidectomy in 6 cases and total thyroidectomy in 2 cases, with irradiation in 7 cases. In 2 cases the patients are alive and well 19 months and 8 years, respectively, after the onset of symptoms. A third patient has survived 10 months, but has a residual tumour; 5 patients died 3-10 months after the onset of symptoms. The thyroid glands in 7 of the 11 cases exhibited the simultaneous occurrence of a malignant lymphoma and the classic lesions of Hashimoto disease. The Hashimoto process was diffuse in 4 cases and focal in 3; it was noted in thyroid lobes uninvolved by the tumour and in residual segments of thyroid lobes invaded by the lymphoid neoplasm. These Hashimoto lesions showed characteristic epithelial

PART III—ABSTRACTS

alterations in addition to diffuse or focal lymphoid infiltration. In 1 case in the series, the clinical and pathological findings indicated that the onset of a growing thyroid tumour 1 year before had been preceded by thyroid enlargement of 4 years' duration, the result of hyperinvolvement and extensive Hashimoto disease. The benign lymphoid tissue and the neoplastic lymphoid tissue showed distinctly different histological and cytological appearances; cellular pleomorphism, mitotic activity and marked invasion characterized the malignant tissue, while lymphoid follicles, and a close relationship to small thyroid follicles with Askany changes in the epithelial cells were typical of Hashimoto disease.

Lindsay, S., and Dailey, M. E. (1955). *J. clin. Endocrin.*, 15, 1332.

Carcinoma of the thyroid in children

Treatment—Childhood thyroid carcinoma is discussed by BUCKWALTER (1955). Among 79 new patients with carcinoma of the thyroid, seen during a period of 5 years, 8 (10.1 per cent) were under the age of 15 years, indicating that this lesion has an age incidence quite different from that of other malignant neoplasms. The series of 8 children comprised 4 females and 4 males; their ages at onset ranged from 7 to 14 years; the intervals prior to treatment varied from 1 to 24 months, the site of the presenting lesion was the thyroid in 5 cases and a node in 3 cases. The results of a follow-up study shows that 7 of the patients are cancer-free, after periods varying from 2 months to 5 years; 1 patient died from the neoplasm after 7 months. In 3 instances, external irradiation had been administered during infancy, for the treatment of an enlarged thymus, 2 siblings of 1 of these patients died during infancy, allegedly because of an enlarged thymus, each of them having received irradiation therapy, and the possibility that the masses treated were thyroid lesions cannot be entirely excluded. An enlarged cervical lymph node was the first clinical manifestation in 3 cases; the lesions in 2 of these cases were predominantly follicular adenocarcinomas and in the other it was a papillary adenocarcinoma. The results of thyroid function tests suggested a euthyroid state. Operation revealed lymph-node involvement in 7 cases (bilateral in 5); 1 case showed direct invasion of the trachea, pre-thyroid muscles were involved in 4; no gross neoplasm remained after definitive surgery in 4 cases. The microscopic diagnosis was follicular adenocarcinoma in 4 cases, papillary carcinoma in 3, and small-cell carcinoma in 1. In most instances, the primary treatment was complete surgical extirpation of the gross neoplasm; tracheotomy was performed in 3 cases. The post-operative morbidity was low and there was no mortality. Radioactive iodine was the most valuable method of adjunctive therapy. Any non-tender mass in the thyroid gland or cervical region of a child, without upper respiratory infection or exanthem, should be considered as carcinoma until disproved by biopsy. The majority are differentiated lesions, more frequent in younger patients and marked by a prolonged course and late metastases, the undifferentiated lesions are characterized by early metastases and a progressive and usually fatal course. The results obtained with radio-iodine in the present series justify its further use.

Buckwalter, J. A. (1955). *J. clin. Endocrin.*, 15, 1437.

Results of conservative operation

The results of conservative operations for malignant tumours of the thyroid are discussed by CRILE, SUHRER and HAZARD (1955). A review has been made of all the malignant tumours of the thyroid seen by the first author during the period 1937-54; of 182 such tumours, 59 per cent were papillary carcinomas. Patients with papillary carcinoma comprised a secondary group of 33 who had had a previous operation on the thyroid and a primary group of 74 who had not had a previous operation on the thyroid itself but which included 23 who had had neck dissections or biopsies of cervical nodes. An analysis of the extent of disease found at the authors' operations showed carcinoma in thyroid and cervical lymph node metastases in 47 primary and 22 secondary cases, carcinoma in thyroid without cervical lymph node metastases in 27 primary cases only, lymph node metastases without carcinoma in thyroid in 11 secondary cases only, and distant metastases in 4 primary and 3 secondary cases. The types of operation used included partial or total lobectomy; subtotal or total thyroidectomy, unilateral or bilateral removal of lymph nodes only; palliative excision of part of the thyroid tumour, and distant metastases in 4 primary and 3 secondary cases. The data show that excellent results may be achieved by conservative operations on most papillary carcinomas and their follicular variants if the primary tumour is completely excised and the grossly involved lymph nodes are removed. A papillary carcinoma is, apparently, often disseminated and rendered incurable by biopsy or partial excision. In non-papillary carcinomas, the results depend more on the type of tumour than on the type of treatment. The study suggests that radical mutilating surgery is seldom if ever indicated in these cases.

Crile, G., Jr., Suhrer, J. G., Jr., and Hazard, J. B. (1955). *J. clin. Endocrin.*, 15, 1422.

Treatment of metastatic carcinoma with radio-iodine

MALOOF, VICKERY and RAPP (1955) present an evaluation of various factors influencing the treatment of metastatic thyroid carcinoma with I^{131} . They survey a group of 21 selected patients with these growths. The primary tumour was classified as adenocarcinoma arising in an adenoma in 10 patients; as follicular adenocarcinoma in 5, as mixed papillary and follicular in 4, as pure papillary in 1, and as Hurthle-cell adenocarcinoma in 1. Surgical total thyroidectomy was performed in 15 patients. Following this an uptake of I^{131} was induced in the metastases of 7 of the 15 and was increased in the metastases of 5 other patients

associated with growth of the metastases resulting indirectly from TSH stimulation. This may outweigh the benefit deriving from increasing the avidity of the tumour for I^{131} . Since the effect of anti-thyroid drugs in increasing the I^{131} uptake may be diminished once radio-iodine is given, the effect of the isotope in the metastases. Concerning functional variations it appears that certain

hormone from a portion only of the tumour mass. However, such variations in the same patient may defeat the attempt of the physician to treat the lesion successfully with I^{131} .

URETER—TRANSPLANTATION OF

See also B S P, Vol 8, p 370, S. Key 335.

Uretero-ileostomy

Post-operative examination by pvelography

READ
Multiple problems
ureters into an isolated segment of the gastro-intestinal tract and to construct continent artificial urinary reservoirs, have not been satisfactory. In 1952, Bricker reported 55 cases of uretero-ileostomy, with an operative mortality of 3.2 per cent. Pyelograms were reviewed in terms of "renal units", of 35 normal pre-operatively, 71 per cent were "satisfactory" after surgery, particularly regarding nephrosis. Pyelonephritis occurred in 28 per cent cases, hyperchloraemic acidosis was absent. The authors have performed the Bricker type of operation on 11 patients with favourable results. The cases are reported, the sixth demonstrating that uretero-ileostomy is a feasible secondary procedure which may be undertaken when renal failure threatens. Pyelograms revealed that 6 of 7 renal units, normal before diversion, maintained normal function subsequently, in only 1 case were hydro-ureter and hydronephrosis evident. Pre-operative obstruction returned to normal in 3 of 5 units; pyelonephritis occurred in 1 case. Hyperchloraemic acidosis was not observed. The operative procedure is a modification of Bricker's. The ureters are transplanted into a short ileal loop,

end-to-side anastomoses are performed by the mucosa-to-mucosa technique; purse-string sutures stabilize the catheter, preventing leakage of urine and enabling urine volumes to be accurately measured.

Read, G. R., and Hurwitz, A. (1955). *New Engl. J. Med.*, 252, 341.

Uretero-sigmoidostomy

Post-operative complications

therefore, even at the expense of continence. An isolated ileal segment to carry the urine to a surface bag vies with the alternative of a rectal bladder, constituting a low pressure, sterile, continent reservoir. Reflux of faeces-contaminated urine after transplantation, produces upper tract dilatation, pyelonephritis, renal damage and hyperchloraemic acidosis. Reflux depends largely upon patent ureteral orifices and difference between high rectal voiding pressure and lower ureteral secretory pressure. Rectal defaecation pressure is mainly due to the action of the diaphragm and abdominal muscles on straining. Colostomy makes straining unnecessary. Moreover, material is propelled by peristalsis throughout the cc patient with a rectal bladder voids at low pressure. High voiding pressure in the presence of secondary effects: pyelonephritis, reabsorption of

After uretero-sigmoidostomy, urine can travel up the colon to the caecum. Colostomy reduces the area exposed to urine and should reduce reabsorption. Since acidosis cannot be corrected once renal damage exists, colostomy should be done concurrently with uretero-sigmoidostomy. Similarly, since sterilization of the rectal segment would eliminate pyelonephritis, antibacterial therapy, as well as colostomy, is indicated at the time of ureteral transplantation. The choice between a stoma in the abdominal wall and a colostomy is a difficult one. The authors, however, feel that a rectal bladder with sigmoidostomy offers a practical substitute for the normal organ and advise early sigmoidostomy.

Smith, G. I., and Hinman, F., Jr. (1955). *J. Urol.*, 74, 354.

URETHRA AND BLADDER : CONGENITAL MALFORMATIONS

See also B.S.P., Vol. 8, p. 383, S. Key 336.

Diverticulum of the anterior portion of the urethra

Clinical examination and urethrography

He presented with a subacute urinary infection. Urethrography of the anterior portion of the urethra showed a diverticulum. He was treated by periodical dilatation and became symptom-free. Case III, aged 61 years, had undergone surgical operation 5 years previously when suprapubic and perineal suppuration had been removed. He presented 18 months later the prostate was resected and vesical calculi removed. He is performed.

Murphy, L. (1955). *Med. J. Aust.*, 2, 922.

See also B.S.P., Vol 8, p 407, S. Key 337.

Neonatal obstruction

Diagnosis

Urethrography.—STEPHENS (1955) writes on urethral obstruction in childhood and the use of urethrography in diagnosis. Over a period of 5 years a series of 175 patients whose ages ranged from newborn to puberty were studied, on whom 241 micturition-cystourethrograms were made, some of them post-operative. Of these, 103 showed normal urethrograms with or without upper urinary tract abnormalities. In 32 cases congenital

bulbo-cavernous muscle. Also it was possible to display the effective action of the external sphincter which is distributed over a greater length of urethra in children than is usually described for adults. This method also showed that, by comparison, the internal sphincter occupied a very short band. These zones were checked by corresponding micro-anatomical studies. Correlation of the urethrographic criteria of valvular obstruction with the actual post-mortem specimens of this disease led to a more detailed study of the normal and

was completely bifurcated when the valves arose directly from the verumontanum. Consequently, it could be postulated that valves were abnormalities of this crest and that the crest developed as a bilateral structure. Further evidence as to the origin of the terminal fins and the inferior urethral crest was suggested by the study of 1 post-mortem case of a newborn male infant in whom the kidneys and all structures derived from the Wolffian ducts were lacking. In this urethral specimen, the verumontanum was slightly elongated, but the inferior crest and fins were absent. The absence of the fins and crest in this 1 case suggested that these structures may well be intimately associated with the development of the Wolffian ducts, that they represent traces of the terminal ends of these ducts which during development are taken up into the urogenital sinus, transferring the orifices from their original sites near the cloacal membrane to the final position on the verumontanum,

corresponded to the external sphincter and to that sleeve of involuntary muscle which lies internal to this structure. Urethrography further suggested that during voluntary attempts to micturate the zone of the sphincter occupied by the internal sphincter might actually widen

Stephens, F. D (1955) *Aust. N Z J. Surg*, 25, 89

UTERUS—CERVIX; AND VAGINA

See also B.S.P., Vol 8, p. 451, S. Key 341

Carcinoma of the cervix

Reappearance 30 years after treatment, case history

HOWKINS and (1955)
30 years after
in a multiparous
of radium for
sponge carrier
yearly until 1939 and no evidence of a recurrence was observed. In 1954 she returned with a history of vaginal bleeding for 3 days' duration. A friable ulcer was found eroding the

PART III—ABSTRACTS

atrophied cervix and infiltrating the vaginal vault, and was confirmed by biopsy to be a fairly well-differentiated squamous-celled carcinoma. Although great technical difficulty was encountered due to dense masses of adhesions, a Wertheim's hysterectomy was successfully performed. As the original biopsy section cannot be traced, the aetiology in this case remains obscure.

Howkins, J., and Andrews, J. D. (1955). *J. Obstet. Gynaec. Brit. Emp.*, 62, 870.

VASCULAR SURGERY

See also B.S.P., Vol. 8, p. 489, S. Key 343.

Acquired tricuspid stenosis

Clinical diagnosis and treatment

CHESTERMAN and WHITAKER (1955) describe the diagnosis and surgical treatment of acquired tricuspid stenosis. The clinical diagnosis may be made by noting the giant "a" waves, the absence of pulmonary hypertension, the presence of the typical tricuspid diastolic murmurs, and the electrocardiographic evidence of an increased and pointed P wave in lead II. Some of these points may be absent or equivocal in patients with tricuspid stenosis. In that case the pathognomonic sign is the altered pressure gradient found on cardiac catheterization of the right side of the heart. With tricuspid stenosis, moreover, the atrial diastolic pressure is raised above that of the ventricle, and in patients with sinus rhythm the atrial pulse pressure is abnormally high and the pulse pressure is not transmitted to the ventricle. A major problem in treatment is to decide which valve should be operated on first. If in doubt as to which valve was responsible for the greater degree of incapacity the authors prefer to operate on the mitral valve first so as to avoid excessive pulmonary congestion. If the main disability is due to the raised systemic venous pressure they prefer to operate on the tricuspid valve first. Patients are reassessed at short intervals after operation and the second valvotomy is proceeded with when maximum relief has resulted from the first operation.

Chesterman, J. T., and Whitaker, W. (1955). *Thorax*, 10, 321.

Atrial septal defects

Operative repair under direct vision

LEWIS and his colleagues (1955) have repaired 35 atrial septal defects under direct vision and explore the heart digitally through the right auricular appendage. Cardiac inflow and outflow are then occluded, and the right atrium opened widely. After repair the atrium is closed with a clamp over saline, circulation allowed to resume, and the atrial wound sutured. The duration of circulatory stasis was from 3 to 7½ minutes. In all the cases in this series the atrial septal defect was the major anomaly, and the defects were classified into 4 types. Foramen ovale defects are caused either by arrested development of the septum secundum, or by inadequacy of the septum primum. The authors consider the latter to be the more important cause. In some cases the existence of a large valve of the inferior vena cava causes the defect to apparently extend to the right of the caval orifice, and is a serious complication that may lead to fatal misrepair. In some the right pulmonary veins open anomalously into the right atrium, and may require separate anastomosis. The defect is closed with fine silk sutures. Twenty-three cases came into this category. Five cases with high defects were seen; in these, the fossa ovalis was present, the defect being above it just below the superior vena cava. In each, there was anomalous entry of the upper right pulmonary veins. Careful placing of the sutures directed the pulmonary veins into the left atrium and closed the defect. One case had a combined high and foramen ovale defect. This was successfully closed. The fourth group consisted of low defects, stemming from failure of the common atrioventricular canal to close. Three of these had a low defect of the septum, notching of mitral valve cusps in which the atrioventricular valves were not properly developed, and not joined to each other, with a resultant communication between the ventricles. Those with only the atrial septal defect were closed by sutures, but received damage to the atrioventricular node. Those with the more serious type died after attempted repair, one showing signs of mitral stenosis before death. Eleven patients suffered ventricular fibrillation, 10 being successfully defibrillated. The authors conclude that open operative repair of atrial septal defects is a good method except in those cases with the last type of anomaly. Caution is necessary in the repair of low defects, both because of the anatomical difficulties, and because of the possibility of fibrosis producing valvular stenosis.

Lewis, F. J., Tausif, M., Varco, R. L., and Niaz, S. (1955). *Ann. Surg.* 142, 401.

Coarctation of the aorta**Criteria for surgical treatment**

O'Sullivan, W D, and Glenn, F. (1955) *Ann. Surg.*, **142**, 909.

Tetralogy of Fallot**Treatment**

Anastomosis of ascending aorta and main pulmonary artery.—DAVIDSON (1955) describes a case of Fallot's tetralogy in a girl, aged 9, where an anastomosis was made between the

Anastomosis was performed in 1955 and the child made a good recovery. In another case of a boy aged 11 months where angiocardiology showed tetralogy of Fallot, the operation had to be abandoned and the baby died on the same day. Necropsy showed an infundibular stenosis and gross narrowing of the segment containing the pulmonary valve. Judging from the position of the suture line in the ascending aorta it seemed certain that the clamp used in operation had occluded the origin of the left coronary artery.

Davidson, J. S. (1955). *Thorax*, **10**, 348

Intracardiac surgery**Pre-operative assessment and post-operative management**

SELLERS (1955) states that the success of intracardiac surgery depends not only upon accurate surgical technique but also upon careful pre-operative assessment and post-operative management. Preliminary measures include a full clinical and radiological study supplemented by cardiac catheterization and angiocardiology. It may be necessary to alter the plan of operation when the heart is directly inspected at thoracotomy. At this stage the use of a sterile stethoscope applied to the heart surface ensures accurate location of abnormal sounds. Pressure and pulse can be measured by means of a specially adapted catheter inserted

available. Valvotomy for mitral stenosis is the most commonly performed operation in heart surgery. The commissures of the mitral valve are split by forcible pressure with the side of the finger. Sometimes a knife-like instrument is attached to the finger. The mortality from this operation is not greater than 5 per cent. Transventricular valvotomy is performed in cases of pulmonary stenosis, and good results may be obtained from the use of hypothermia. Operations for aortic stenosis, aortic regurgitation and mitral regurgitation yield less satisfactory

PART III—ABSTRACTS

results. With regard to interauricular septal defects a septum primum is less suitable for closure than a septum secundum. Operative treatment is indicated when there is progressive enlargement of the right side of the heart. Direct suture may be performed under open vision, with either hypothermia or an artificial heart-lung. External closure and invagination of the auricle wall are other techniques which may be employed.

Sellers, T. H. (1955). *Brit. med. J.*, 2, 1470.

See also B.S.P., Vol. 8, p. 529, S. Key 344.

VEINS—VARICOSE

Management

Conservative and surgical treatment

COCKETT (1955) describes the management of venous ulcers of the leg. An elastic bandage is applied and the patient is encouraged to exercise the leg and calf. Continuous conservative treatment is reserved for patients in the upper age group and for patients who refuse operative treatment. With regard to diagnosis, the commonest precursor lesion is either a spray of fine dilated venules on the inner surface of the ankle or a firm plaque in the subcutaneous tissue. The plaque consists of oedematous and fibrotic fat with areas of fat necrosis and dilated veins. Ascending venography is employed in order to demonstrate the patency and configuration of the deep veins. Incompetent perforating veins at the ankle may also be demonstrated by means of this technique. When the patient is in the erect position the saphenous system has little place in the venous drainage of the ulcer-bearing area. The essential venous drainage is into the deep veins mainly through the large perforating veins on the inner and outer side of the leg. Hence in the early stages of ulceration large and incompetent perforating veins should be ligated at the ankle. The operation is performed after preliminary massage and the application of supporting bandages. Spirit and Cetavlon applications are used for pre-operative preparation of the skin. With the operating table in a slight Trendelenburg tilt in order to minimize bleeding an incision is made from a point nearly half-way up the leg and one fingerbreadth posterior to the bony margin of the tibia. The incision is continued downwards to a point 1 inch postero-superior to the internal malleolus. Large veins in the subcutaneous tissue are explored until the perforating veins are located. Fine catgut is used for ligating any large perforating veins at the site of their emergence from the deep fascia, then the venous plexus in the subcutaneous tissue is removed. After excision of the ulcer the area is covered with tulle gras. A firm elastic-webbing bandage is applied from the toes to the knees and active movements are instituted as soon as possible. Cockett found incompetent perforating veins in approximately 66 per cent of 201 cases. A history of femoral thrombosis was obtained in 49 of 234 cases, and in this group it was necessary for the patients to continue the use of heavy elastic stockings despite the fact that the operation had proved to be successful in maintaining sound healing of the ulcer. In the majority of cases, however, surgical treatment enabled the patients to discard the stockings either throughout the day or for part of the day.

Cockett, F. B. (1955). *Brit. J. Surg.*, 43, 260.

NOTER-UP, 1956

The Key Numbers in the margins correspond to those in the main volumes, in which they appear at the top left-hand corner of each right-hand page.

Vol. 1

KEY NO.

1 ABDOMINAL EMERGENCIES

Abstracts

- Intestinal rupture following non-penetrating injury [1951], p. 269
- Perforation of the rectum [1951], p. 269
- Primary inflammation of the appendices epiploicae [1951], p. 269
- Closed abdominal injuries, value of early surgical exploration [1955], p. 216
- Laceration of the superior mesenteric artery' treatment [1955], p. 216

2 ABDOMINAL PAIN

Abstract

- Mesenteric cyst aetiology and treatment [1951], p. 270

3 ABDOMINAL WALL

Abstracts

- Retroperitoneal tumours: classification as a guide to clinical diagnosis [1955], p. 217
- Extraperitoneal pneumography in diagnosis of retroperitoneal tumours [1955], p. 217
- Surgical treatment of retroperitoneal tumours [1955], p. 218

4 ABORTION

No further references

5 ABSCESS

No further references

6 ACHLORHYDRIA AND APPETITE

No further references

7 ACIDOSIS

Article

- Fluid and electrolyte balance [1953], p. 91
- Treatment of fluid and electrolyte disturbances [1953], p. 124

8 ACTINOMYCOSIS

Abstracts

- Facial and cervical treatment [1953], p. 273
- Pulmonary treatment [1953], p. 273

Vol. 1

KEY NO.

9 ADHESIONS AND CICATRICAL STENOSES

Abstract

Duodenum, obstruction distal to ampulla of Vater [1956], p. 263

10 ADHESIONS (PLEURAL) IN PULMONARY TUBERCULOSIS

No further references

11 ADIPOSITTY

No further references

12 ADRENAL GLANDS

Article

Adrenalectomy [1955], p. 46

Anatomy of the adrenals [1955], p. 46

Relations and form [1955], p. 46

Fascial attachment [1955], p. 48

Vasc. [1955], p. 48

Unusual sites and accessory adrenals [1955], p. 48

Stages of adrenalectomy [1955], p. 49

The operation [1955], p. 50

Anaesthesia [1955], p. 50

Position of patient and approach [1955], p. 51

Difficulties during operation [1955], p. 54

Post-operative management [1955], p. 55

Effect of adrenalectomy on cancer of the breast and prostate [1955], p. 56

Analysis of 100 patients with cancer of the breast treated by adrenalectomy [1955], p. 58

Summary and conclusion [1955], p. 67

Abstracts

Phaeochromocytoma: bilateral case and new diagnostic tests [1951], p. 270

Endocrine effects of the adrenal glands [1952], p. 205

Phaeochromocytoma: a review of the literature [1953], p. 206

Phaeochromocytoma: a review of the literature [1953], p. 206

Hypofunction and hyperactivity: hazards in anaesthesia and surgical operations [1953], p. 273

Phaeochromocytoma: adrenaline and nor-adrenaline effect on the benzo-dioxane test [1953], p. 274

Total bilateral adrenalectomy: cortisone and glycyrrhizin [1954], p. 248

Cushing's syndrome: treatment [1955], p. 218

Medullary phaeochromocytoma: clinical manifestations and surgical treatment [1955], p. 219

ACTH, cortisone and hydrocortisone in surgery [1956], p. 263

Neuroblastoma in childhood: surgical management [1956], p. 264

13 AFTER-CARE—INTRODUCTION

No further references

[14 AFTER-CARE—FOLLOW-UP

No further references

Vol. 1

KEY NO.

15 AFTER-CARE—METHODS AND VALUE OF MASSAGE

No further references

16 AFTER-CARE—ON RETURN HOME

No further references

17 AFTER-CARE—POST-OPERATIVE

Article

Necrotizing enteritis [1955], p. 104

Incidence [1955], p. 104

Clinical picture [1955], p. 104

Onset [1955], p. 105

Non-fulminating cases [1955], p. 106

Fluid and electrolyte loss [1955], p. 106

Bacteriology [1955], p. 106

Post-mortem findings [1955], p. 106

Microscopy [1955], p. 107

Aetiology [1955], p. 109

Antibiotic-resistant strains of staphylococcus [1955], p. 110

Shock as a causative factor [1955], p. 111

Hypochlorhydria [1955], p. 111

Treatment [1955], p. 111

Prophylactic [1955], p. 111

Definitive [1955], p. 112

Fluid replacement [1955], p. 112

Critical survey

Early ambulation in the post-operative management of general surgical patients [1955], p. 182

Definition [1955], p. 182

General physiological principles and their specific relationship to certain aspects of early ambulation [1955], p. 183

Nutrition [1955], p. 183

Cardiovascular system [1955], p. 184

Pulmonary system [1955], p. 185

Gastro-intestinal system [1955], p. 186

Genito-urinary system [1955], p. 187

The wound [1955], p. 187

The anaesthetic [1955], p. 189

The technique of early ambulation [1955], p. 189

Contra-indications to early rising [1955], p. 190

Psychological aspects [1955], p. 190

Economic factors [1955], p. 190

Abstracts

Pain prevention Elocaine administration [1953], p. 274

Water retention causative factors [1954], p. 248

Water and electrolyte balance control following operation [1955], p. 219

Circulation after operation study and correction of variations [1955], p. 220

18 AFTER-CARE—REMEDIAL AND OCCUPATIONAL THERAPY AND REHABILITATION

Article

Recuperation after operation [1955], p. 114

Introduction [1955], p. 114

Vol. 1

KEY NO.

- 18 AFTER-CARE—REMEDIAL AND OCCUPATIONAL THERAPY AND REHABILITATION (*cont.*):
 Recuperation after operation (cont.)
 Enabling aspect - ...
 ... 115
 Therapeutic work [1955], p. 117
 Physiotherapy [1955], p. 120
 Hydrotherapy [1955], p. 122
 Resettlement [1955], p. 122
 Rehabilitation after meniscectomy [1955], p. 123
- 19 AIR PASSAGES
 Article
 Reconstruction of the trachea, hypopharynx and cervical oesophagus [1951], p. 193
- 20 ALLERGY
 Abstract
 Manifestations following procaine penicillin injection [1952], p. 206
- 21 AMOEBIASIS—AMOEBIC INFECTION OF INTESTINE (PATHOLOGY)
 No further references
- 22 AMOEBIASIS—AMOEBIC INFECTIONS OF INTESTINE (SURGERY)
 No further references
- 23 AMOEBIASIS—LIVER ABSCESS AND PATHOLOGY OF AMOEBIASIS OTHER THAN INTESTINAL
 Abstracts
 Comparison of chloroquine and emetine treatment [1952], p. 207
 Non-hepatic secondary amoebiasis: diagnosis [1952], p. 207
- 24 AMPUTATIONS
 Article
 Pain—painful stumps and phantom limbs [1951], p. 12
 The intercrural-abdominal amputation [1955], p. 81
 Indications for the hindquarter amputation [1955], p. 82
 Technique [1955], p. 84
 Anaesthesia [1955], p. 87
 Artificial limb [1955], p. 87
 Prognosis [1955], p. 87
 Chondrosarcoma [1955], p. 87
 The osteoblastic or osteogenic sarcomas [1955], p. 87
 Malignant osteoclastoma of the hip bone [1955], p. 90
 Sarcomata of the soft tissues [1955], p. 90
 For intrapelvic extension of malignant disease of skin and vulva [1955], p. 91

Vol. 1

KEY NO.

24 AMPUTATIONS (cont.)

Abstracts

- Ischaemia of the leg treated by amputation [1952], p. 207
 Arteriosclerosis: clinical history and pathology of limb [1954], p. 249
 Hemipelvectomy [1954], p. 249
 Knee disarticulation: advantages over thigh amputation [1955], p. 220
 Choice of technique in senile gangrene [1955], p. 220

25 AMYLOID INFILTRATION (AMYLOIDOSIS)

No further references

26 ANAESTHESIA—GENERAL

Critical surveys

- Anaesthesia [1952] p. 127
 Contributory factors in the evolution of anaesthetic technique [1952], p. 127
 Muscular relaxation [1952], p. 129
 Local and regional analgesia [1952], p. 133
 Planned hypotension [1952], p. 137
 Conclusion [1952], p. 149
 Anaesthesia—recent advances in pre-operative and post-operative medication [1955], p. 161
 Assessment and reassurance of patient [1955], p. 161
 Pre-operative medication [1955], p. 161
 Drugs given the night before operation [1955], p. 161
 Drugs given shortly before operation [1955], p. 162
 Basal narcosis [1955], p. 163
 The phenothiazine derivatives [1955], p. 164
 Premedication in special conditions [1955], p. 165
 Medication during operation [1955], p. 167
 Induced hypotension [1955], p. 167
 Induced hypothermia [1955], p. 167
 Post-operative medication [1955], p. 167
 Stimulation of respiration [1955], p. 167
 Drug treatment of shock [1955], p. 167
 Drugs for the relief of post-operative pain [1955], p. 168

Abstracts

- Cyclopropane effects of raised airway pressure during [1952], p. 208
 Complications of endotracheal anaesthesia, laryngeal sequelae [1952], p. 208
 Relaxants: abnormal sensitivity to [1953], p. 275
 Controlled hypotension [1954], p. 250
 Effects on blood-sugar [1954], p. 250
 Major operations on exsanguinated patients: anaesthetic technique [1955], p. 221
 Analgesia in the treatment of compression fractures: technique [1955], p. 221
 Application of anaesthesia to diagnostic urology: toxic reactions [1955], p. 222
 Pethidine: venous reactions [1955], p. 222

Vol. 1

KEY NO.

27 ANAESTHESIA—LOCAL
No further references

28 ANAESTHESIA—REGIONAL
No further references

29 ANAESTHESIA—SPINAL
Abstract

30 Results of continuous caudal analgesia in 12,000 deliveries [1951], p. 271
ANGINA PECTORIS
Abstracts

31 Resection of afferent pathway [1954], p. 251
ANGIOMA
Abstracts

32 Stellate ganglion block [1956], p. 266
Diathermy treatment of haemangioma and lymphangioma [1952], p. 209
Surgical removal [1952], p. 209
ANTHRAX
Abstract

Chloramphenicol in treatment of cutaneous anthrax [1952], p. 209
ANTIBIOTICS
Article

Antibiotics [1954], p. 183

Introduction [1954], p. 183

Aureomycin and tetracycline [1954], p. 183

Chloramphenicol [1954], p. 186

Polymyxins [1954], p. 187

Bacitracin [1954], p. 188

Erythromycin and carbomycin [1954], p. 188

Development of bacterial resistance [1954], p. 189

Penicillin [1954], p. 189

Streptomycin [1954], p. 190

Broad spectrum antibiotics [1954], p. 190

Staphylococcus pyogenes [1954], p. 190

Other bacteria [1954], p. 191

Cross-resistance [1954], p. 191

Bacterial dependence and stimulation [1954], p. 191

Combined chemotherapy [1954], p. 192

Synergism and antagonism [1954], p. 192

33 ANUS, ARTIFICIAL (MANAGEMENT)
No further references

34 ANXIETY STATES
No further references

35 APPENDICITIS, ACUTE
Article

Appendicitis and peritonitis [1951], p. 32
Abstract

Appendectomy: reduction in mortality rate [1955], p. 223
[330]

Vol. 1

KEY NO

36 APPENDIX—TUMOURS OF

Abstract

Adenocarcinoma of appendix: symptoms and signs [1954], p 251

37 ARTERIES

Article

Arterial grafting [1953], p. 1

Introduction [1953], p. 1

The fate of blood vessel transplants [1953], p. 1

The collection of arterial grafts [1953], p. 4

Storage [1953], p. 5

Indications for arterial grafting [1953], p. 11

Treatment of arteriosclerosis [1953], p. 16

Conclusion [1953], p. 39

Abdominal aortography [1955], p. 1

Definition [1955], p. 1

Historical [1955], p. 1

Contra-indications [1955], p. 1

Translumbar aortography [1955], p. 1

Apparatus [1955], p. 2

Anaesthesia [1955], p. 2

Aortic puncture [1955], p. 4

Retrograde femoral catheterization [1955], p. 5

Dangers and complications [1955], p. 6

Aortography in renal conditions [1955], p. 9

Indications [1955], p. 9

The normal arteriogram [1955], p. 9

The abnormal arteriogram [1955], p. 13

Aortography in vascular abnormalities [1955], p. 39

Indications [1955], p. 39

Conclusions [1955], p. 44

Critical survey

Progress in arterial surgery [1951], p. 209

Abstracts

Thrombo-angitis obliterans of renal artery [1952], p. 210

Physiology and relief of traumatic arterial spasm [1952], p. 210

Aneurysm: resection of descending thoracic aorta [1952], p. 210

Dissecting aneurysm of abdominal aorta with secondary renal dysfunction [1952], p. 211

Spontaneous thrombosis [1954], p. 251

Abdominal aortic aneurysms [1954], p. 252

Arterial aneurysms [1954], p. 252

Ischaemic lower limb [1954], p. 253

Aortic grafts [1954], p. 253

Acute arterial embolism [1954], p. 254

Arterial aneurysms [1954], p. 254

Arterial aneurysms [1954], p. 254

Arterial aneurysms [1954], p. 254

Arterial aneurysms [1954], p. 254

Arterial aneurysms [1954], p. 254

Arterial aneurysms [1954], p. 254

Arterial aneurysms [1954], p. 254

Arterial aneurysms [1954], p. 254

Arterial aneurysms [1954], p. 254

Arterial aneurysms [1954], p. 254

Arterial aneurysms [1954], p. 254

Obliterative vascular disease: clinical and pathological analysis of 368 cases [1955], p. 224

Femoral embolectomy following acute coronary occlusion: technique [1955], p. 225

Arterial homografts: animal experiments in chemical sterilization [1955], p. 225

Vol. 1

KEY NO.

37 ARTERIES (cont.):

Abstracts (cont.):

Arteriosclerosis obliterans: reconstructive surgery of the femoral artery [1955], p. 227

Plethysmographic studies following vasodilation in patients with arteriosclerosis obliterans [1955], p. 227

Ruptured aortic aneurysm, surgical treatment [1956], p. 266

[1956], p. 267

Renal arteriography: dangers [1956], p. 268

38 ARTHRITIS—SURGICAL CONSIDERATIONS

Article

Chronic arthritis [1952], p. 1

Osteoarthritis [1952], p. 1

Rheumatoid arthritis [1952], p. 30

Abstracts

Acrylic splint for the hand [1952], p. 211

Clinical picture and pathology of osteoarthritis [1953], p. 275

Knee: arthroplasty [1954], p. 254

Osteoarthritis of the hip: aetiology, morbid anatomy and symptomatology [1955], p. 229

Osteochondritis dissecans following ankle injuries [1956], p. 268

Arthrodesis of the hips: avoidance of post-operative complications [1956], p. 268

39 ARTIFICIAL LIMBS

Abstract

Preparation of stump for artificial limb: leg pylons [1952], p. 212

40 ARTIFICIAL PNEUMOTHORAX

No further references

41 ASEPSIS AND ANTISEPSIS

Article

Antibiotics [1951], p. 19

42 ASYMMETRY

No further references

43 AUTONOMIC NERVOUS SYSTEM: INTRODUCTION

Abstracts

Clinical manifestations of autonomic dysfunction [1951], p. 276

Transmission of stimuli to effector organs: the chemical concept [1951], p. 276

Vol. 1

KEY NO.

44 AUTONOMIC NERVOUS SYSTEM: ANATOMY

Article

Anatomy of the autonomic nervous system [1951], p. 39

45 AUTONOMIC NERVOUS SYSTEM: ARTERIES

Critical survey

Obliterative arterial disease [1951], p. 214

Raynaud's disease [1951], p. 216

Abstracts

Indications for, and results of, surgery [1951], p. 277

Blindness due to vascular occlusion: treatment by stellate-ganglion block [1952], p. 212

Posterior upper thoracic sympathectomy: improved method of approach [1956], p. 269

Vol. 2

46 BACKACHE

No further references

47 BACTERAEMIA

No further references

48 BACTERIOLOGY

Abstracts

Newborn infants, carriage rates and antibiotic resistance of staphylococci [1955], p. 230

Cross-infection in hospital wards: reduction by suppression of dust on floors and bedclothes [1955], p. 230

Study of antiseptic hand cream in the control of cross-infection [1955], p. 231

Prevention of cross-infection by treatment of carriers [1955], p. 231

49 BASAL METABOLISM

Abstract

Interferometric studies [1952], p. 212

50 BEDS, PLASTER

No further references

51 BEDSORES

No further references

52 BIOCHEMICAL TESTS—CURVES AND CHARTS

Abstract

Functional changes in the liver following surgery for portal hypertension: metabolic effects [1955], p. 232

53 BITES AND STINGS

No further references

Vol. 2

KEY NO.

54 BLADDER—INFECTIONS

Abstracts

- Use of liquid paraffin in removing light foreign bodies from the bladder* [1951], p. 277
- Abacterial cystitis of possibly spirochaetal origin* [1952], p. 213
- Abacterial cystitis: symptoms and treatment* [1954], p. 255
- Prolonged catheterization causing bacteriological changes* [1955], p. 232

55 BLADDER INJURIES

Article

- The treatment of injuries of the urethra and bladder* [1954], p. 17
- Introduction* [1954], p. 17
- Treatment of injuries of urethra* [1954], p. 18
 - Sequelae of urethral injuries* [1954], p. 18
 - Cause of stricture formation* [1954], p. 18
 - Principles of treatment* [1954], p. 19
- Actiology and morbid anatomy* [1954], p. 20
- Diagnosis* [1954], p. 21
- Treatment* [1954], p. 21
- Diversion of urine from injured area* [1954], p. 22
- After-treatment* [1954], p. 25
- Suprapubic drain* [1954], p. 26
- Dilatation of urethra* [1954], p. 26
- Late complications* [1954], p. 26
- Rupture of the posterior urethra* [1954], p. 28
 - Actiology and morbid anatomy* [1954], p. 28
 - Diagnosis* [1954], p. 29
 - Treatment* [1954], p. 29
 - Other modes of treatment* [1954], p. 33
 - Later complications* [1954], p. 34
- Treatment of injuries of the bladder* [1954], p. 35
 - Ruptures of the bladder* [1954], p. 35
 - Treatment* [1954], p. 36
 - Penetrating injuries* [1954], p. 36
 - Treatment* [1954], p. 36
 - Surgical injuries of the bladder* [1954], p. 37
 - Injuries of female bladder and urethra* [1954], p. 38

Abstract

- Injuries of the female bladder* [1954], p. 213

56 BLADDER—NEUROGENIC DISTURBANCES

Abstract

- Surgical treatment: pudendal nerve interruption* [1955], p. 233

57 BLADDER—POUCHES

Abstracts

- Vesical neck obstruction: actiology and treatment* [1955], p. 233
- Bladder-neck obstruction in children: treatment* [1955], p. 234

58 BLADDER—TUMOURS

Abstracts

- Carcinoma of the urachus [1952], p. 214
- Results of treatment [1952], p. 214
- Infiltrating carcinoma of the bladder: early diagnosis [1953], p. 276
- Results of total cystectomy for carcinoma [1953], p. 276
- Primary bladder tumours: primary sarcoma [1954], p. 256
- Mucinous adenocarcinoma of the urachus: treatment [1955], p. 234
- Aetiology: role of urinary enzymes [1955], p. 235
- Carcinoma of the urachus: case report [1956], p. 269
- Treatment of bladder tumours by cobalt-bomb radiation [1956], p. 269
- Reimplantation of ureter following bladder carcinoma [1956], p. 270
- Infiltrating carcinoma: treatment [1956], p. 270

59 BLINDNESS—MANAGEMENT OF

No further references

60 BLOOD AND BLOOD-FORMING ORGANS: BLOOD EXAMINATION

Article

- Sickle cell anaemia—radiological features [1955], p. 126
- Aetiology [1955], p. 126
- Radiological changes [1955], p. 126
- Chest [1955], p. 126
- Abdomen [1955], p. 127
- Skeletal system [1955], p. 127
- Avascular necrosis [1955], p. 129
- Osteomyelitis [1955], p. 135

Abstracts

- Simulation of surgical conditions in sickle cell anaemia [1951], p. 278
- Coagulation: role of coagulase-globulin [1953], p. 276
- Thrombin conversion: prothrombin determination [1953], p. 277
- Blood volume and volume of erythrocytes: effect of Dextran [1953], p. 277

61 BLOOD PRESSURE: HIGH AND LOW

Critical survey

- Treatment of hypertension [1952], p. 151
- General considerations [1952], p. 151
- Essential hypertension [1952], p. 152
- Treatment of some diseases associated with hypertension [1952], p. 158

Abstracts

- Treatment of hypertension with hexamethonium compounds [1952], p. 215
 - Treatment of essential hypertension by sub-total adrenalectomy [1952], p. 216
 - Hypertension: adrenal resection and sympathectomy [1954], p. 256
 - Essential hypertension: management of the malignant phase [1955], p. 235
- [335]

Vol. 2

KEY NO.

62 BLOOD TRANSFUSION—PRACTICE

Critical survey

- Blood transfusion [1954], p. 194
 - General [1954], p. 194
 - Blood groups [1954], p. 194
 - Direct matching test [1954], p. 196
- Indications for transfusion [1954], p. 197
 - Platelet deficiency [1954], p. 198
 - Other clotting elements [1954], p. 198
 - Leucocytes [1954], p. 198
- Transfusion fluids [1954], p. 198
 - Stored citrated blood [1954], p. 198
 - Concentrated red cells [1954], p. 199
 - Fresh citrated blood [1954], p. 199
 - Plasma and serum (liquid and dried), [1954], p. 199
 - Plasma substitutes [1954], p. 200
 - Plasma fractions [1954], p. 201
 - Albumen solution [1954], p. 202
- Organization of a hospital blood bank [1954], p. 202
- Apparatus [1954], p. 203
- Collection of blood [1954], p. 203
- Technique of transfusion [1954], p. 203
- Complications of transfusion [1954], p. 207
 - Pyrexial [1954], p. 207
 - Haemorrhagic states [1954], p. 205
 - Haemolytic anaemia [1954], p. 206
 - Pre-operative and post-operative transfusion [1954], p. 206

Abstract

Attendant dangers: incompatibility and other factors associated with the donor [1955], p. 236

63 BLOOD TRANSFUSION—THEORY

Abstracts

Abstracts of papers presented at the 1955 meeting of the Society for the Study of Blood Transfusion [1955], p. 278

64 BOILS, CARBUNCLES, FURUNCULOSIS

No further references

65 BONE GRAFTING

Abstract

Malformation of the jaws: co-ordinated methods of treatment [1955], p. 236

Acute infections of bone [1951], p. 91

Diagnosis and treatment of osteitis pubis [1951], p. 280
Osteitis pubis of non-haematogenous origin [1951], p. 281
Osteosclerosis: aetiology, diagnosis and treatment [1953], p. 278
Osteomyelitis: treatment [1953], p. 279
Osteomyelitis and chondritis: treatment [1953], p. 279
Thiemann's disease. clinical picture [1955], p. 237
Osteomyelitis: treatment by cancellous bone grafts [1955], p. 237

Abstracts

Polyostotic fibrous dysplasia [1952], p. 217
Symptoms of infantile hyperostosis [1953], p. 279

Abstracts

Changes in the jaws in generalized skeletal disease [1952], p. 217
Leontiasis ossia: clinical picture and pathology [1954], p. 257
Porotic and malacic conditions of bone: histopathology [1955], p. 238

Abstracts

Osteoma of cranial bones treated surgically [1952], p. 218

Sarcoma, extra-osseous or intra-osseous [1952], p. 219

Sarcoma osteogenic [1952], p. 220

Diagnosis and treatment of osteoid-osteoma, fibrous dysplasia and eosinophilic granuloma in children [1953], p. 280

Plasmacytoma: progression to myelomatosis [1953], p. 280

Malignant osteoclastoma: clinical picture, treatment and end-results [1953], p. 281

Treatment of radial tumour [1953], p. 281

Epidermoid carcinoma of the temporal bone: prognosis [1955], p. 238

Incidence of malignant cells in bone-marrow aspirations: primary source [1956], p. 271

Osteogenic sarcoma: incidence, sites, spread and treatment [1956], p. 271

Benign giant-cell tumour of femur [1956], p. 271

Liposarcoma in the femur: case report [1956], p. 272

70 BRACHIAL PLEXUS

Article

- Post-operative brachial plexus paralysis [1953], p. 43
- Introduction [1953], p. 43
- Extent of the paralysis [1953], p. 43
- Associated injuries [1953], p. 44
- Nature of operation [1953], p. 45
- Anaesthetic [1953], p. 45
- Length of operation [1953], p. 46
- Position on the table [1953], p. 46

BRACHIAL PLEXUS (cont.):

Post-operative brachial plexus paralysis (cont.):
 Other aetiological factors [1953], p. 49

Mechanism of injury [1953], p. 50

Prevention [1953], p. 53

Treatment [1953], p. 57

Prognosis [1953], p. 58

Medico-legal aspects [1953], p. 58

BRAIN—ABSCESS*Abstracts*

Otogenic cerebellar abscess [1952], p. 270

Treatment by aspiration

End-results of treatment

Otic origin of brain abscess
 p. 272

...ent by otological approach [195

BRAIN—CONGENITAL DEFECTS

No further references

BRAIN—FUNGUS

No further references

BRAIN—INJURIES AND COMPLICATIONS*Article*

Brain—spontaneous intracranial haemorrhage [1956], p. 1

Introduction [1956], p. 1

Aetiology and pathology [1956], p. 1

Aneurysms [1956], p. 1

Angiomatous malformations (angiomas) [1956], p. 3

Haemorrhage from unknown cause [1956], p. 5

Hypertensive cerebro-vascular disease [1956], p. 5

Unusual causes [1956], p. 5

Clinical diagnosis [1956], p. 5

Diagnosis of intracranial haemorrhage [1956], p. 5

Diagnosis of the causative lesion [1956], p. 9

The differential diagnosis of haemorrhage [1956], p. 13

Radiological diagnosis [1956], p. 16

Plain x-rays [1956], p. 16

Angiography [1956], p. 16

Prognosis [1956], p. 18

Aneurysms [1956], p. 18

Angiomatous malformations [1956], p. 18

Treatment of intracranial aneurysms [1956], p. 19

General management [1956], p. 19

When to operate [1956], p. 19

Carotid artery ligation in the neck [1956], p. 20

Direct attack on the aneurysm [1956], p. 22

Summary of the treatment of aneurysms [1956], p. 26

Treatment of angiomatous malformations [1956], p. 26

Considerations regarding operation [1956], p. 26

Indications for operation [1956], p. 28

Radical excision [1956], p. 29

Radiotherapy and symptomatic treatment [1956], p. 29

Intracerebral and subdural haematomas [1956], p. 31

Vol. 2

KEY NO.

72 BRAIN—INJURIES AND COMPLICATIONS (*cont.*).

Abstracts

- Relation of injury to subsequent brain tumour and neural sclerosis [1952], p. 222
 Major closed head injuries [1954], p. 258
 Acute epidural haematoma of the posterior fossa: treatment [1955], p. 239
 Extradural haemorrhages of the posterior fossa: classification and clinical features [1955], p. 239
 Subacute and chronic subdural haematoma: treatment [1955], p. 239
 Posterior fossa haematoma: case reports [1956], p. 273
 Head injury: delayed complications [1956], p. 273
 Extradural haemorrhage: mortality rate [1956], p. 273

75 BRAIN—NEUROLOGICAL INVESTIGATION AND SPECIAL TESTS

Article

- Surgical treatment of involuntary movements [1954], p. 55
 Introduction [1954], p. 55
 Anatomy and physiology [1954], p. 55
 Clinico-pathology [1954], p. 57
 Indications for surgical investigation [1954], p. 58
 Cortical excision [1954], p. 58
 Subcortical operations [1954], p. 59
 Choroidal artery occlusion [1954], p. 60
 Pedunculotomy [1954], p. 61
 Cordotomy [1954], p. 64

Abstracts

- Angiography in diagnosis of brain abscess [1952], p. 223
 Carotid arteriography—error of technique [1952], p. 223
 Intracranial venography of dural sinuses [1952], p. 223
 Ventriculography and encephalography: use in control of radiotherapy [1952], p. 224
 Radioactive minerals in diagnosis [1952], p. 224
 Uses of nuclear disintegration in diagnosis and treatment of brain tumour [1952], p. 224

76 BRAIN—TUMOURS AND TECHNIQUE

Critical survey

- Pre-frontal leucotomy [1952], p. 162

Abstracts

- Incidence of tumours in idiopathic symmetrical hyperostosis of skull [1952], p. 225
 Symptoms simulating meningitis [1952], p. 225
 Operative mortality: analysis of operation and necropsy findings [1952], p. 225
 Operative mortality: danger of air embolism at operation [1952], p. 226
 Operative mortality: oligodendroglioma [1952], p. 226
 Diagnosis and localization of intracranial lesions by radioactive substances [1953], p. 282
 Extradural haematoma: differential diagnosis [1953], p. 283
 Meningioma: aetiology [1953], p. 283
 Medulloblastoma: diagnosis, treatment and end-results [1953], p. 284
 Posterior fossa dermoid cysts: aetiology [1953], p. 284
 Acoustic neuromas in children: two case reports [1955], p. 240

Intracranial aneurysm [1956], p. 274

77 BREAST—CARCINOMA OF

Abstracts

Surgical treatment: operability and end-results [1953]. p. 284

Medical treatment: sex hormones [1953], p. 285

Treatment: spread of secondaries to internal mammary lymph nodes (1954), p. 256

Ovarian activity in breast cancer [1954], p. 258

Glandular metastasis [1954], p. 259

Analysis of 5-year survival rate at small and large hospitals (1955), p. 240

Latent carcinoma: activation by febrile illness [1955], p. 241

Adrenal-dependent mammary cancer: study of 100 cases [1955], p. 241

Treatment by bilateral adrenalectomy [1955], p. 241

Methods of spread of mammary cancer [1956], p. 274

78 BREAST—CARCINOMA OF. POST-OPERATIVE RADIOTHERAPY

No further references

79 BREAST—CHRONIC MASTITIS

Article

Innocent lumps in the breast [1951], p. 100

80 BREAST—INFECTIONS

No further references

81 BRONCHIECTASIS

Abstracts

Sloughs of the tracheal mucosa associated with bronchiectasis [1951].
p 288

Aqueous contrast media in bronchography [1952], p. 226

Bronchography in infants and very young children [1952], p. 227

Resection in treatment of bronchiectasis [1956], p. 274

82 BURNS AND SCALDS

Article

Treatment of burns [1952], p. 38

Introduction [1952], p. 38

Classification [1952], p. 38

The burn problem [1952], p. 38

Abstracts

11. *agromorpha* *in pascuis* *hirsuta* *110491* n 227

7. 232

p. 229

Disinfection: penicillin, dibromopethamidine, terramycin, and aureomycin [1952] p. 239

Enzymatic debridement [1952], p. 230

[340]

Vol. 2

KEY NO

82 BURNS AND SCALDS (cont.).

Abstracts (cont.):

Ocular burns: corrosion caused by quick-lime [1953], p. 286
 Burns: treatment of neglected burn [1954], p. 259
 Severe and extensive burns. influence of modern techniques and drugs on survival rate [1955], p. 242
 Treatment by exposed and closed methods [1955], p. 242
 Methods of treatment according to degree [1955], p. 243
 Burns: amino-acid loss in urine [1956], p. 275

83 BURSAE

Abstract

Tuberculous subdeltoid bursitis two case reports [1955], p. 243

Vol. 3

84 CAESAREAN SECTION

Abstract

Cystographic studies in placenta praevia [1951], p. 288

85 CAROTID BODY

Article

The syndrome of the carotid sinus [1953], p. 60

Introduction [1953], p. 60

Anatomy [1953], p. 60

Physiology [1953], p. 61

Surgical treatment [1953], p. 66

86 CELLULITIS, LYMPHANGITIS, ERYSIPELAS

Abstract

Lymphangitis. treatment of lymphoedema [1955], p. 244

87 CELLULITIS—PELVIC

No further references

88 CERVICAL RIB AND THE SCALENUS SYNDROME

No further references

89 CHEMICAL WARFARE—SURGICAL ASPECTS OF

No further references

90 CHEMOTHERAPY

Critical survey

The chemotherapy of malignant diseases [1953], p. 256

Introduction [1953], p. 256

Chemotherapy of cancer [1953], p. 256

CHEMOTHERAPY (cont.):

The chemotherapy of malignant diseases (cont.):
 Endocrine therapy of tumours other than those of the prostate and breast [1953], p. 260

Hormonal treatment of haemopoietic disorders [1953], p. 260
 Cortisone ACTH in leukaemia and allied diseases [1953], p. 260

The nitrogen mustards [1953], p. 261
 Hodgkin's disease, the leukaemias and reticulososes [1953], p. 261

Bronchogenic carcinoma [1953], p. 262
 Triethylenesulphonobutane (Myleran) in the treatment of chronic myelogenous leukaemia [1953], p. 265

I : 4-Dimethanesulphonobutane (Myleran) in the treatment of chronic myelogenous leukaemia and allied conditions [1953], p. 265
 Administration [1953], p. 267

Side-effects [1953], p. 268

Treatment of multiple myeloma [1953], p. 268
 Antagonists of folic acid and of the "citrovorum" factor in the treatment of acute leukaemia [1953], p. 268

The clinical use of radioactive isotopes [1953], p. 269

Abstract

Chemotherapy in cancer: present status of the postulates of Koch [1955], p. 244

91

CHORDOMA*Abstracts*

Sacro-coccygeal chordoma and chordoma in other areas [1951], p. 288
 Thoracic chordomas [1952], p. 230

92

CICATRICES, INCLUDING KELOID

No further references

93

CIRCUMCISION

No further references

94

CISTERNAL PUNCTURE

No further references

95

COAGULANTS AND ANTICOAGULANTS*Critical survey*

Introduction [1951], p. 219

Abstracts

Haemorrhage following use of Tromexan [1952], p. 231
 Experiments with dicoumarol [1952], p. 231

96

COLIC

No further references

97

COLITIS*Abstracts*

Total colectomy [1952], p. 231
 Diagnosis and treatment of chronic ulcerative colitis [1953], p. 287
 Indications for and results of surgical treatment of chronic ulcerative colitis [1953], p. 287

Vol. 3

KEY NO.

97 COLITIS (cont.):

Abstracts (cont.):

- Advances in procedure of surgical treatment for chronic ulcerative colitis [1953], p. 288
- Ulcerative colitis: surgical management [1954], p. 260
- Total colectomy: one-stage procedure [1954], p. 260
- Anorectal complications: surgical treatment [1955], p. 245
- Diagnostic procedure [1955], p. 245
- Complication due to treatment by aureomycin [1955], p. 246
- Pathology of regional colitis: observations from a series of 25 specimens [1955], p. 246

98 COLON—CARCINOMA OF

Article

- The treatment of carcinoma of the colon [1953], p. 71

75

- Treatment of carcinoma of the colon without acute obstruction [1953], p. 77
- Treatment of carcinoma of the colon with acute obstruction [1953], p. 82

Abstracts

- Aetiology, malignancy following treatment [1953], p. 288
- Classification: diagnostic difficulties [1955], p. 247
- Polyps of the colon incidence and treatment [1956], p. 277

99 COLON—DEVELOPMENTAL ABNORMALITIES AND MEGACOLON

Article

- Hirschsprung's disease [1951], p. 163

Abstracts

- Hirschsprung's disease treatment; colectomy and ileo-anostomy [1954], p. 261
- Megacolon and associated bladder dysfunction, elimination as a post-operative complication [1956], p. 277
- Radiological investigation of megacolon and bladder abnormality [1956], p. 277

100 COMPENSATION, DAMAGES AND PENSIONS

No further references

101 CONJUNCTIVA—DISEASES AND INJURIES

Abstracts

- Aetiology of angular conjunctivitis [1952], p. 232
- Appearance and differential diagnosis of implantation cyst following injury [1953], p. 289

102 CONSTIPATION

No further references

CONTRACTURES*Abstract*

Torticollis: breech delivery as causative factor [1955], p. 247

CORNEA—DISEASES AND INJURIES*Critical survey*

The surgery of corneal grafts [1953], p. 242
 Historical survey [1953], p. 242

Types of keratoplasty [1953], p. 243
 Indications for keratoplasty [1953], p. 244

Selection of cases [1953], p. 245
 Methods of operation [1953], p. 246

Post-operative treatment [1953], p. 249
 Factors which influence the course of corneal grafts [1953], p. 250

Results of operation [1953], p. 251
 Clinical analysis [1953], p. 252

The donor problem [1953], p. 254
 Conclusions [1953], p. 255

Abstracts

Cortisone in treatment of interstitial keratitis [1952], p. 232
 Bullous keratitis: treatment by neurectomy [1952], p. 233
 Efficacy of streptomycin in experimental and clinical infections [1952], p. 289

DACTYLITIS*No further references***DEFORMITIES***Abstracts*

Arthrogryposis: aetiology and treatment [1951], p. 291
 Pectus excavatum: operative treatment [1951], p. 291
 Madelung's deformity: treatment [1955], p. 248

Congenital dislocation of the hip [1955], p. 248

DERMOID AND EPIDERMOID CYSTS*No further references***DIABETES MELLITUS IN RELATION TO SURGERY***Abstracts*

Pregnancy in diabetic patients: foetal mortality [1951], p. 292
 Treatment of diabetes: alcohol injection of splanchnic nerves [1951], p. 292
 Charcot's joints in diabetic neuropathy [1952], p. 234

Neuropathic joints [1952], p. 234
 Pre-operative insulin recommendation [1953], p. 289

DIVERTICULA OF THE ALIMENTARY TRACT*Abstracts*

Diverticula of third part of duodenum [1951], p. 293
 Sigmoido-cutaneous fistulae due to diverticulitis of the sigmoid colon [1951], p. 293
 Diagnosis and treatment of acute diverticulitis of the caecum [1951], p. 294

Bleeding Meckel's diverticulum [1952], p. 234
 [344]

Vol. 3

KEY NO.

109 DIVERTICULA OF THE ALIMENTARY TRACT (continued)

Abstracts (cont.).

Meckel's diverticulum: intussusception [1955], p. 267

Diverticulitis of the colon: surgical treatment [1955], p. 225

Symptoms and treatment of diverticulitis of the colon [1955], p. 247

110 DUCTUS ARTERIOSUS

No further references

111 EAR—AVIATION, SURGICAL ASPECTS OF

Abstract

Blast perforation of the ear-drum: aetiology and treatment [1955], p. 21

112 EAR—EXTERNAL EAR

Abstracts

Delayed onset of symptoms due to foreign bodies [1951], p. 207

Pathology and treatment of painful helicine nodules [1953], p. 22

113 EAR—INTERNAL EAR, ACUTE INFECTION

Abstracts

Sympathectomy and its influence on aural lesions [1952], p. 21

Pathology of vascular tumours [1953], p. 290

114 EAR—INTERNAL EAR, CHRONIC INFECTION (NOVEMBER)

Abstract

Preservation of the labyrinth [1952], p. 235

115 EAR—MALDEVELOPMENTS OF

Abstracts

Deformities encountered in a microtic ear [1953], p. 21

Middle ear malformations and related conditions

The auditory meatus in mongolism [1955], p. 24

116 EAR—OTALGIA

No further references

117 EAR—OTTIS MEDIA, ACUTE MASTOIDITIS

No further references

118 EAR—OTTIS MEDIA, CHRONIC CATARRH

No further references

119 EAR—OTTIS MEDIA, CHRONIC SUPPURATIVE

No further references

120 EAR—OTTIS MEDIA, EXUDATIVE

No further references

IIION

67

18

Vol. 3

KEY NO.

121 EAR—OTOSCLEROSIS

Abstracts

- Haemostasis during fenestration operations [1951], p. 296
- Some difficulties arising with fenestration operation [1952], p. 236
- Treatment by Lempert's fenestration [1955], p. 250
- Selection of patients for fenestration [1955], p. 250
- Results of fenestration [1955], p. 250
- Post-operative care and assessment of results of fenestration [1955], p. 251

122 EFFUSIONS

No further references

123 ELECTRICAL REACTIONS OF MUSCLE AND NERVE

No further references

124 ELECTROCARDIOGRAPHY IN SURGICAL PROGNOSIS

No further references

New ELECTRONICS

Heading

Article

- The applications of electronics to clinical practice [1954], p. 67
- Introduction [1954], p. 67
- Functions of electronics in clinical work [1954], p. 67
- Basic principles [1954], p. 68
- Thermionic valves [1954], p. 68
- Methods of display [1954], p. 74
- Control by electronics [1954], p. 86
- Electronics in therapy [1954], p. 87
- Non-electrical quantities [1954], p. 82
- Control by electronics [1954], p. 86
- Electronics in therapy [1954], p. 87

125 ELEPHANTIASIS

Abstract

- Post-operative lymph fistula case reports [1956], p. 278

126 EMBOLISM—AIR, PATHOLOGY

No further references

127 EMBOLISM—FAT, PATHOLOGY

No further references

128 EMBOLISM—AIR AND FAT, CLINICAL ASPECT

Abstract

- Relation between tissue injury and pulmonary fat embolism [1955], p. 251

129 EMPHYSEMA—SURGICAL

No further references

130 ENOMETRIOSIS

Abstract

- Pathogenesis of endometriosis: implantation-induction theory [1956], p. 278

Vol. 3

KEY NO.

131 ENDOSCOPY—BRONCHOSCOPY

Abstracts

Diagnosis of foreign bodies [1951], p 297

Foreign bodies in bronchi: incidence and treatment [1956], p 279

132 ENDOSCOPY—CYSTOSCOPY

No further references

133 ENDOSCOPY—GASTROSCOPY

No further references

134 ENDOSCOPY—OESOPHAGOSCOPY

No further references

135 ENDOSCOPY—PERITONEOSCOPY

No further references

136 ENDOSCOPY—SIGMOIDOSCOPY

No further references

137 ENDOSCOPY—URETHROSCOPY

No further references

138 EPIPHYSES—DISEASES OF

Abstracts

Osteochondritis dissecans: aetiology [1955], p 252

Familial incidence of osteochondritis dissecans [1955], p 252

139 EYE—CONGENITAL ABNORMALITIES: HEREDITY IN RELATION TO EYE DISEASE

Abstract

The clinical status of the contact lens [1951], p. 297

140 EYE—EXAMINATION OF, IN SURGICAL DIAGNOSIS

No further references

141 EYE—INJURIES: NON-INDUSTRIAL, INDUSTRIAL, WAR

No further references

142 EYE IN RELATION TO ENDOCRINE DISTURBANCE

Article

Malignant exophthalmos [1952], p. 60

Benign exophthalmos without ophthalmoplegia [1952], p 67

Benign exophthalmos with ophthalmoplegia [1952], p 68

Abstract

Malignant exophthalmos [1954], p. 261

143 EYE—THERAPEUTICS OF

Abstract

Treatment of eye emergencies [1956], p. 279

Vol. 3

KEY NO.

NOTER-UP, 1956

- 144 **EYE—TROPICAL AND NUTRITIONAL DISEASE**
No further references

- 145 **EYE—TUBERCULOSIS**
No further references

- 146 **EYELIDS**
No further references

Vol. 4

- 147 **FACIAL PALSY**

Abstracts

Traumatic palsy: indications and technique for surgical treatment [1951], p. 298

Traumatic palsy: management and surgical treatment [1953], p. 291

Idiopathic paralysis: symptoms [1953], p. 291

Facial-nerve decompression [1953], p. 291

- 148 **FACIO-MAXILLARY INJURIES AND DEFORMITIES**

Abstracts

Fractures of the maxillae: diagnosis and treatment [1951], p. 298

Dental aspects of treatment of clefts and perforations of the palate [1951], p. 299

Operative technique for cleft lip [1951], p. 299

Operative technique for cleft palate and hare-lip [1951], p. 300

Surgical treatment of hare-lip with double cleft and displaced pre-maxilla [1951], p. 300

Transparotid resection of lower jaw for tumours [1951], p. 301

Fractures of nasal pyramid [1954], p. 262

Complex fractures of middle third of face [1954], p. 263

Fracture of the zygoma: treatment [1955], p. 252

- 149 **FALLOPIAN TUBES**

Abstract

Primary carcinoma: aetiology and treatment [1953], p. 292

- 150 **FASCIAL GRAFTS**

Abstract

Suspension of the ptosed kidney by means of a fascia lata graft [1951], p. 103

- 151 **FAT NECROSIS**

No further references

- 152 **FIBROSITIS**

No further references

- 153 **FILARIASIS**

No further references

Vol. 4

KEY NO

154 FISTULA IN ANO

Abstracts

Classification and treatment [1955], p. 253

Ano-rectal fistula: aetiology and surgical treatment [1956], p. 280

155 FOCAL EPILEPSY

Abstracts

Temporal-lobe epilepsy: treatment [1955], p. 253

156 FOOT—SURGERY OF

Abstracts

Hallux valgus and hallux rigidus: treatment [1953], p. 292

Flat foot: end-result of surgical treatment [1953], p. 293

Club-foot: treatment [1953], p. 293

Hallux valgus: surgical treatment [1955], p. 254

157, 158, 159 FRACTURES, DISLOCATIONS, FRACTURE-DISLOCATIONS
AND ALLIED INJURIES

Articles

Fractures of the pelvis [1953], p. 192

Avulsion fractures [1953], p. 192

Fractures and dislocations of the pelvic ring [1953], p. 192

Fracture of the sacrum [1953], p. 200

Fracture of the coccyx [1953], p. 200

Fracture of the acetabulum [1953], p. 200

Fractures and dislocations of the talus [1955], p. 68

Classification [1955], p. 68

Mechanism [1955], p. 70

Clinical features and treatment [1955], p. 71

Fractures [1955], p. 71

Fracture-dislocations [1955], p. 74

Astraglectomy and arthrodesis [1955], p. 78

Tibio-calcaneal or tibio-talo-calcaneal fusion [1955], p. 79

Abstracts

Wrist injury [1954], p. 265

Internal derangements of temporomandibular joint [1954], p. 265

Fractures of the scaphoid [1955], p. 254

Intracapsular fracture of the neck of the femur [1955], p. 255

Delayed union and non-union: pathogenesis and treatment [1955], p. 255

Condylar fractures of the knee joint [1955], p. 256

Patella: recurrent dislocation [1956], p. 280

Fracture of the patella: treatment [1956], p. 280

Femoral neck: non-union after displaced intracapsular fractures [1956],
p. 282

Displacement osteotomy of upper end of femur [1956], p. 282

FROST-BITE

Abstracts

- Surgical treatment: end-results of sympathectomy [1953], p. 293
 Bone changes: study of series in Korea [1955], p. 256

161

GALL-BLADDER AND BILE PASSAGES

Article

- Injuries and strictures of the bile-ducts [1954], p. 1
 Traumatic rupture of the bile-ducts [1954], p. 1
 Aetiology [1954], p. 1
 Clinical picture [1954], p. 1
 Treatment [1954], p. 2
 Prognosis [1954], p. 4
 Operative and post-operative injuries and strictures [1954],
 Aetiology [1954], p. 4
 Precautions in biliary tract surgery [1954], p. 9
 Management of post-operative strictures [1954], p. 9
 Pre-operative treatment [1954], p. 9
 Operative principles [1954], p. 9
 Immediate repair of duct injuries [1954], p. 11
 Exposure and repair of post-operative biliary tract strictures [1954], p. 11
 Exposure [1954], p. 11
 Prognosis [1954], p. 16

Abstracts

- Repair of injuries, recurrent stricture [1952], p. 237
 Post-operative use of split T-tube [1952], p. 237
 Biliary tract disorders: surgical treatment [1953], p. 294
 Acute inflammatory conditions [1953], p. 295
 Cholelithiasis: predisposing factors [1953], p. 295
 Ascending cholangitis and biliary cirrhosis [1953], p. 295
 Gall-bladder disease [1954], p. 265
 Common bile-duct: idiopathic dilatation [1954], p. 266
 Cholelithiasis: geographical incidence [1955], p. 257
 Common duct stones: diagnostic procedures [1955], p. 257
 Malignant tumours: treatment [1955], p. 257
 Common bile-duct obstruction: surgical management [1955], p. 258
 Complications following choledochal sphincterotomy [1955], p. 259
 Atresia of the common bile-duct [1955], p. 260
 Surgery of the biliary tract [1955], p. 260
 Methods of examination, cholecystography [1955], p. 261
 Cholangiography in radiological examinations [1955], p. 261
 Value of cholangiography to obviate secondary operations [1955], p. 261
 Survey of current opinions on cholangiography [1955], p. 262
 Value of cholangiography in estimation of liver function [1955], p. 262
 Methods of examination: intravenous cholecystangiography [1956], p. 282
 Intravenous cholecysto-cholangiography in gall-bladder examination [1956], p. 283
 Biliary tract and pancreatic surgery [1956], p. 283
 Biliary tract disease: diagnosis and treatment [1956], p. 284
 Cholecystic and coronary disease [1956], p. 284
 Cholangitis, choleduodenostomy [1956], p. 284
 Cholelithiasis: cholecystectomy [1956], p. 285
 Neoplasms of gall-bladder and bile ducts [1956], p. 285
 [1956]

Vol. 4

KEY NO.

162 **GANGLION**

No further references

163 **GANGRENE, CLOSTRIDIAL (GAS GANGRENE)**

No further references

164 **GASTRO-COLIC FISTULA**

Abstracts

Gastro-jejuno-colic fistula a report on two cases [1951], p. 307

Gastro-jejuno-colic fistula clinical picture and treatment [1956], p. 286

165 **GASTROSTOMY**

No further references

166 **GENITAL ORGANS—FEMALE EXTERNAL**

Abstract

Vulva. carcinoma [1956], p. 286

167 **GLAND-PUNCTURE AND ASPIRATION BIOPSY**

Abstract

Tumour diagnosis technique of trephine biopsy [1955], p. 262

168 **GLANDERS**

No further references

169 **GLAUCOMA**

Abstracts

Pathogenesis aqueous veins [1951], p. 308

Surgical relief of glaucoma [1951], p. 308

Glaucoma associated with polycystic disease of the kidney [1952], p. 237

Glaucoma secondary to uveitis cortisone treatment [1952], p. 238

170 **GLOMUS TUMOURS**

Article

Tumours of the glomus jugulare or tympanic body [1954], p. 89

Definition [1954], p. 89

Historical [1954], p. 89

Aetiology [1954], p. 89

Surgical anatomy [1954], p. 89

Pathology [1954], p. 89

Clinical picture [1954], p. 93

Diagnosis [1954], p. 100

Aids to diagnosis [1954], p. 100

Differential diagnosis [1954], p. 100

Prognosis [1954], p. 100

Treatment [1954], p. 101

Surgical treatment [1954], p. 101

Chemotherapy [1954], p. 101

Anaesthesia [1954], p. 101

Radiotherapy [1954], p. 101

Results of treatment [1954], p. 103

171 **GLOTTIS—OEDEMA OF**

No further references

NOTER-UP, 1956

Vol. 4

KEY NO.

172 GONORRHOEA

Abstract

Antibiotic treatment in the female [1952], p. 238

173 GOUT

No further references

174 GUNSHOT WOUNDS AND ALLIED INJURIES. (GENERAL MANAGEMENT)

Critical survey

Surgery in Korea [1954], p. 242

General medical arrangements [1954], p. 242

General principles of war surgery [1954], p. 242

Resuscitation [1954], p. 243

Whole blood [1954], p. 243

Plasma [1954], p. 243

Antibiotics [1954], p. 243

Frost-bite [1954], p. 243

Prevention [1954], p. 243

Treatment [1954], p. 244

Casualty evacuation by helicopter [1954], p. 244

Body armour [1954], p. 245

Vascular surgery [1954], p. 245

Neurosurgery [1954], p. 245

Brain injury [1954], p. 246

Spinal injuries [1954], p. 246

Chest wounds [1954], p. 246

Renal insufficiency [1954], p. 246

Abstract

Wounds of the thorax and abdomen: treatment [1956], p. 286

175 HAEMATOMA

Abstracts

Haematoma of the umbilical cord [1951], p. 309

Extradural haematoma [1952], p. 238

176 HAEMOPHILIA AND OTHER HAEMORRHAGIC STATES

Abstract

Aetiology: circulating coagulant [1954], p. 266

177 HAEMORRHAGE

Abstracts

Upper gastro-intestinal haemorrhage [1952], p. 239

Idiopathic thrombopenic purpura effects of ACTH and cortisone on the platelet count [1953], p. 296

Haemostasis: value of prothrombin tests [1955], p. 263

178 HAND

Critical survey

Infections [1951], p. 231

Trauma [1951], p. 233

Abstracts

Reconstruction of the thumb: choice of method [1953], p. 216

Dupuytren's contracture: clinical features and treatment [1955], p. 263

[352]

Vol. 4

KEY NO.

178 HAND (cont.):

Abstracts (cont.):

- Extensor tendons: treatment of recurrent dislocation [1955], p. 264
- Minor injuries: standardized methods of treatment [1955], p. 264
- Industrial injuries: management by the industrial surgeon [1955], p. 264
- Major infections of the hand: diagnosis and treatment [1956], p. 287
- Dupuytren's contracture: incidence, aetiology and predisposing causes [1956], p. 287

179 HEART AND PERICARDIUM

Article

- Chronic constrictive pericarditis [1953], p. 87
 - Definition [1953], p. 87
 - Aetiology [1953], p. 87
 - Pathology [1953], p. 87
 - Clinical picture [1953], p. 87
 - Special aids to diagnosis [1953], p. 88
 - Differential diagnosis [1953], p. 88
 - Surgical treatment [1953], p. 88
 - Results of treatment [1953], p. 90

Abstracts

- Post-operative changes in output [1952], p. 239
- Chronic constrictive pericarditis: diagnosis and treatment [1955], p. 265

180 HERNIA

Article

- Recurrent hernia [1951], p. 146

Abstracts

- Recurrent inguinal hernia: skin-grafting at operation [1952], p. 240
- Oesophageal hiatus hernia: operative procedure [1953], p. 297
- Intersigmoid hernia [1954], p. 266
- Complications: incarceration of a double loop [1955], p. 265
- Perineal hernia causing acute intestinal obstruction [1955], p. 266
- Treatment: results in 867 primary indirect inguinal hernioplasties [1955], p. 266
- Inguinal herniorrhaphy: criticism of procedures [1956], p. 288
- Problems in the treatment of hernia [1956], p. 288
- Retromesocolic hernia [1956], p. 289

181 HERNIA—DIAPHRAGMATIC

Abstracts

- Traumatic hernias of the diaphragm [1951], p. 313
- Differential diagnosis from coronary artery disease [1951], p. 314
- Surgical anatomy: the crura of the diaphragm [1955], p. 266

182 HERPES ZOSTER

No further references

183 HETEROTOPIA

No further references

184 HICCUP

No further references

Vol. 5

KEY NO.

185 HODGKIN'S DISEASE, OTHER RETICULOSES, RETICULO-SARCOMA AND MYELOMATOSIS

Abstract

Hodgkin's disease [1954], p. 267

186 HORMONES

Abstract

Hypothyroidism [1954], p. 267

187 HYATID DISEASE

Abstract

Operative removal of univesicular pulmonary hydatid cyst [1951], p. 314

188 HYPERHIDROSIS AND ALLIED STATES

No further references

189 HYPERPIESIA

No further references

190 IMMERSION-FOOT

No further references

191 IMPOTENCE

No further references

192 INFECTION, INFECTIONS AND INFLAMMATION

Critical survey

The general pathology of repair [1955], p. 192

Introduction [1955], p. 192

General biology of the repair process [1955], p. 192

General pathology of repair [1955], p. 192

Traumatic inflammation [1955], p. 194

Traumatic inflammation [1955], p. 194

Traumatic inflammation [1955], p. 194

Demolition [1955], p. 194

Demolition [1955], p. 194

1, 196

Traumatic inflammation [1955], p. 194

Traumatic inflammation [1955], p. 194

Traumatic inflammation [1955], p. 194

Traumatic inflammation [1955], p. 194

Traumatic inflammation [1955], p. 194

Traumatic inflammation [1955], p. 194

Traumatic inflammation [1955], p. 194

Traumatic inflammation [1955], p. 194

Traumatic inflammation [1955], p. 194

Traumatic inflammation [1955], p. 194

Traumatic inflammation [1955], p. 194

Traumatic inflammation [1955], p. 194

Traumatic inflammation [1955], p. 194

Abstract

Cortisone: use in suppressing inflammatory reactions [1956], p. 289

[354]

Vol. 5

KEY NO.

193 INJURY—CIVIL AND INDUSTRIAL

Abstract

Road accidents: analysis of type of injury and vehicle in 717 cases [1955], p. 267

194 INJURY—COMPRESSION

No further references

195-199 INTESTINES

Critical survey

Intestines [1952], p. 171

Congenital anomalies [1952], p. 171

Extensive resection of small intestine [1952], p. 173

Regional ileitis [1952], p. 173

Neoplasms of the small intestine [1952], p. 174

Intestinal obstruction [1952], p. 175

Varieties of intestinal obstruction [1952], p. 178

Abstracts

Multiple argentaffinomas of the ileum [1952], p. 240

Argentaffinoma of ileum with perforation [1952], p. 240

Congenital duodenal obstruction and mongolism [1952], p. 241

Congenital duplication of the small intestine [1952], p. 241

Technique of surgery of the colon [1955], p. 267

Duodenal obstruction due to annular pancreas [1955], p. 268

Ileostomy dysfunction: mechanism and prevention [1955], p. 268

Regional ileitis: history and morbid anatomy [1955], p. 269

Acute post-operative enteritis: severe intestinal bleeding supervening [1955], p. 269

Congenital obstruction of the small intestine: surgical treatment [1955], p. 270

Benign tumours of the small intestine [1956], p. 289

Malignant argentaffinoma of the small intestine [1956], p. 290

Primary mesenteric venous thrombosis: symptoms and treatment [1956], p. 290

Congenital atresia below the duodenum: operative mortality [1956], p. 291

200 INTUSSUSCEPTION

Abstracts

Adult incidence: aetiology and symptomatology [1955], p. 270

Recurrent ileocolic intussusception associated with hypertrophy of Peyer's patches [1956], p. 291

201 ISCHAEMIA

No further references

202 JAUNDICE

Abstracts

Intrahepatic obstructive jaundice of unknown aetiology [1952], p. 241

Surgical treatment: value of operative cholangiography [1955], p. 271

Obstructive jaundice: clinical diagnosis [1956], p. 291

Diagnostic procedures in obstructive jaundice [1956], p. 292

Decompression of hepatic duct system [1956], p. 292

203 JOINTS—ARTHROGRAPHY

No further references

Vol. 5

KEY NO.

204 JOINTS—CAISSON DISEASE OF

No further references

205 JOINTS—INJURIES AND ACUTE INFECTIONS

Abstract

Temporomandibular arthrosis: traumatic causation [1955], p. 271

206 JOINTS—INTERNAL DERANGEMENTS OF THE KNEE

No further references

207 JOINTS—TUBERCULOSIS

Article

Bone and joint tuberculosis. the value of antibiotics [1954], p. 42

Assessment of treatment [1954], p. 42

Diagnosis [1954], p. 42

Time factor in assessing results [1954], p. 43

Case studies [1954], p. 44

Antibiotics an enabling agent [1954], p. 48

Essential facts of anti-tuberculous chemotherapy [1954], p. 50

Streptomycin [1954], p. 50

Para-aminosalicylic acid [1954], p. 50

Iso-nicotinic acid hydrazide [1954], p. 50

Abstracts

Streptomycin in surgery [1952], p. 242

Treatment by chemotherapy [1955], p. 272

Use of anti-tubercular drugs in joint tuberculosis [1956], p. 293

208 KIDNEY AND URETER—CYSTS

Article

Hydro-ureter [1955], p. 93

General causes of bilateral hydro-ureter [1955], p. 93

Polyuria [1955], p. 93

Infection [1955], p. 93

Pregnancy [1955], p. 94

Bladder disorders [1955], p. 94

96

Diagnosis [1955], p. 101

Treatment [1955], p. 101

Abstracts

Polycystic disease: radical operation [1952], p. 242

209 KIDNEY AND URETER—DENERVATION OF THE KIDNEY

Abstract

Nephroptosis: nephropexy [1956], p. 293
[356]

Vol. 5

KEY NO.

210 KIDNEY AND URETER—GROWTHS

Abstracts

- Haemangioma: clinical picture [1952], p. 243
- Thrombosis of vena cava associated with renal neoplasia [1952], p. 244
- Retrocaval displacement [1952], p. 244
- Transthoracic nephrectomy [1952], p. 244
- Malignant tumours: symptoms, diagnosis and treatment [1953], p. 297
- Late metastasis from renal carcinoma [1953], p. 297
- Haemangioma of kidney [1954], p. 268
- Neuroblastoma of kidney [1954], p. 269
- Perinephric cysts [1954], p. 269
- Renal hypoplasia [1954], p. 269
- Disease of the ureteric remnant following nephrectomy [1955], p. 273

211 KIDNEY AND URETER—HYDRONEPHROSIS AND PYONEPHROSIS

Abstracts

- Transparietal puncture of the renal pelvis [1951], p. 317
- Plastic repair of retrocaval ureter [1951], p. 317
- Congenital hydronephrosis due to ureteropelvic obstruction [1955], p. 274

New KIDNEY AND URETER—NEPHRECTOMY

Heading *Critical survey*

- Partial nephrectomy [1956], p. 189
 - History [1956], p. 189
 - Definition [1956], p. 189
 - Indications [1956], p. 189
 - Localized renal calculi [1956], p. 189
 - Renal tuberculosis [1956], p. 205
 - Solitary cyst and localized hydrocalyx [1956], p. 211
 - Removal of infarcted and severely lacerated portion of kidney [1956], p. 211
 - Tumours [1956], p. 212
- General principles in the operation of partial nephrectomy [1956], p. 212
 - How much renal tissue is necessary to sustain life ? [1956], p. 212
 - Control of infection [1956], p. 212
 - Operation for bilateral disease [1956], p. 213
 - Incision, exposure and mobilization of the kidney [1956], p. 213
 - X-ray examination of the exposed kidney [1956], p. 214
 - Haemostasis [1956], p. 216
 - Control of haemorrhage during section of the kidney [1956], p. 217

Primary haemorrhage [1956], p. 222

Vol. 5

KEY NO.

212 KIDNEY AND URETER—STONE

Abstracts

- Non-opaque urinary calculus [1954], p. 270
- Impacted ureteric calculus; treatment [1955], p. 274
- Mechanism of renal calculus formation [1955], p. 274
- Anuria: complication of retrograde pyelography [1955], p. 275
- Modification of urinary surface tension [1955], p. 275
- Ion-binding properties of electrophoretically homogeneous muco-proteins of urine [1955], p. 276
- Mechanism of the formation and control of calculus disease by the kidney [1955], p. 276

213 KIDNEY AND URETER—TUBERCULOSIS

Abstracts

- Obstruction of the ureter and its pelvis due to tuberculosis [1955], p. 277
- Investigation of conservative methods of treatment [1956], p. 294
- Selective principle in treatment of urogenital tuberculosis [1956], p. 294
- Chemotherapy in treatment of renal tuberculosis [1956], p. 295
- Treatment with different preparations of PAS [1956], p. 295

214 LACRIMAL APPARATUS—INJURIES AND DISEASES

Abstracts

- Primary adenocarcinoma of the lacrimal gland [1952], p. 245
- Mixed tumour of lacrimal gland [1952], p. 245

215 LARYNX—DIRECT LARYNGOSCOPY AND ASPIRATION TREATMENT IN LARYNGEAL DIPHTHERIA

No further references

216 LARYNX—SURGICAL DISEASES OF

Articles

- Speech after laryngectomy [1954], p. 105
- Normal mechanism of voiced speech [1954], p. 105
- Whispering [1954], p. 106
- Historical [1954], p. 106
- Oesophageal speech [1954], p. 106
- Education in oesophageal speech [1954], p. 110
- Alternative methods [1954], p. 111
- Artificial larynx [1954], p. 111
- Buccal speech [1954], p. 113
- Electric vibrator [1954], p. 113
- Whisper [1954], p. 115
- Pharyngo-oesophago-laryngectomy [1954], p. 115

Critical survey

- Paralysis of the larynx [1956], p. 224
- Central paralysis [1956], p. 224
- Peripheral paralysis [1956], p. 224
- Bilateral abductor paralysis [1956], p. 224
- Symptoms [1956], p. 225
- Surgical treatment [1956], p. 225
- Tracheostomy [1956], p. 226
- Nerve suture and nerve anastomosis [1956], p. 226
- Nerve section [1956], p. 226

216 LARYNX—SURGICAL DISEASES OF (cont.):

Paralysis of the larynx (cont.):

Surgical treatment (cont.):

Excision of the vocal cords [1956], p. 227

Ventriculectomy or ventricle stripping [1956], p. 227

Anterior cordopexy [1956], p. 227

Posterior cordopexy [1956], p. 227

Arytenoidectomy [1956], p. 230

Submucous excision of the cord and arytenoid cartilage [1956], p. 231

Choice of treatment [1956], p. 233

Abstracts

Streptomycin in the treatment of scleroma [1951], p. 318

Indications for a preliminary tracheotomy [1951], p. 318

Surgery after failure of radiotherapy for carcinoma [1952], p. 245

Emergency operations for the treatment of grave dyspnoea [1952], p. 246

Malignant disease: treatment by radiotherapy [1953], p. 298

217 LAW IN RELATION TO SURGERY

Critical survey

Developments in the law in relation to surgery [1955], p. 176

Consent to operations and criminal liability [1955], p. 176

Sterilization [1955], p. 176

The liability of hospitals for negligence [1955], p. 177

Differentiation between professional and ministerial duties [1955], p. 177

Terms of contracts for professional services [1955], p. 178

Recovery of damages from the servant by the hospital [1955], p. 179

Limitation of actions [1955], p. 180

218 LENS—DISEASES AND INJURIES

Abstract

Cataract intra-ocular acrylic lenses in post-operative management [1952], p. 246

219 LEPROSY

Article

Hand reconstruction in leprosy [1954], p. 117

Distribution of nerve lesions [1954], p. 117

Anatomical grouping [1954], p. 118

Analysis of hand disability [1954], p. 118

Fingers [1954], p. 118

Functions in the normal hand [1954], p. 118

Effects of paralysis [1954], p. 119

Pre-operative care [1954], p. 121

Anaesthesia [1954], p. 121

Operative technique [1954], p. 122

Alternative procedure [1954], p. 122

Unusual features [1954], p. 123

219 **LEPROSY (cont.):**

Hand reconstruction in leprosy (cont.):

Analysis of hand disability (cont.):

The paralysed thumb [1954], p. 123

Disability [1954], p. 123

Pre-operative care [1954], p. 123

Operation [1954], p. 124

Tendon transplantation [1954], p. 125

Advanced paralysis [1954], p. 128

Rehabilitation [1954], p. 128

220 **LIGATURES AND SUTURES**

No further references

221 **LIMBS—ABSENCE OF**

No further references

222 **LIPOID METABOLISM AND LIPOID GRANULOMA**

No further references

223 **LIVER—CIRRHOSIS**

Article

Portal hypertension [1953], p. 202

Introduction [1953], p. 202

Anatomical and physiological considerations [1953], p. 202

Pathology of portal obstruction [1953], p. 204

Measurement of portal venous pressures [1953], p. 207

Normal portal venous pressure [1953], p. 207

Symptoms of portal venous obstruction [1953], p. 208

Diagnosis of portal hypertension [1953], p. 209

Portal venography [1953], p. 211

Surgical treatment of portal hypertension [1953], p. 211

Results of portal systemic shunts [1953], p. 219

Emergency treatment of haematemesis from oesophageal varices [1953], p. 221

Summary of surgical treatment [1953], p. 222

Abstracts

Venography: experimental study of hepatic veins [1952], p. 246

Chronic hepatitis with portal hypertension: effect of venous shunt [1952], p. 247

Portal hypertension treated by ligation of hepatic and splenic arteries [1952], p. 247

Portal hypertension: treatment by porta-caval anastomosis [1953], p. 298

Portal hypertension: treatment according to type of obstruction [1953], p. 277

224 **LUMBAR PUNCTURE**

No further references

225 **LUNG—TUMOURS**

Abstracts

Cardiovascular disturbances in bronchial carcinoma [1951], p. 319

Diagnosis of cancer of the lung [1951], p. 319

[360]

Vol. 5

KEY NO.

225 LUNG—TUMOURS (*cont.*):

Abstracts (cont.):

- Incidence of metastasis of lung tumours of the brain [1951], ■ 320
 Carcinoma of the lung: incidence [1952], p. 247
 Coexistence of pulmonary tuberculosis with bronchial carcinoma [1952], p. 248
 Morbid anatomy of cancer of the lung [1953], ■ 298
 Cytology of sputum [1956], p. 295
 Asymptomatic cancer: surgical treatment [1956], p. 296
 Relation of occupation and smoking to lung cancer [1956], p. 296

226 LUPUS VULGARIS

Abstracts

- Intralesional calciferol treatment [1952], p. 248
 Lupus erythematosus: morbid anatomy [1953], p. 299

227 LYMPHOGRANULOMA INGUINALE

No further references

Vol. 6

228 MALINGERING

No further references

229 MANIPULATIVE SURGERY

No further references

230 MEDIASTINUM

Abstract

- Mediastinal fascia: anatomy and applied anatomy [1953], p. 299

231 MELAENA AND BLOOD IN THE STOOLS

Abstract

- Occult blood in faeces [1954], p. 270

232 MELANOMA

Critical survey

- Melanomas and their spread [1956], ■ 236

Time taken for spread [1956], p. 236

During pregnancy [1956], ■ 237

Mode of spread [1956], p. 237

Treatment [1956], p. 240

Abstract

- Treatment of malignant melanoma [1953], p. 300

233 MENINGES—MENINGITIS, ACUTE AND CHRONIC

Article

- Surgical aspects of meningitis [1953], p. 136
 Introduction [1953], p. 136
 Acute pyogenic meningitis [1953], p. 136
 Post-operative meningitis [1953], p. 149
 Surgery of the primary lesion [1953], p. 157

- 233 **MENINGES—MENINGITIS, ACUTE AND CHRONIC (cont.):**
 Surgical aspects of meningitis (*cont.*):
 Surgery of the complications [1953], p. 170
 Surgery of the cerebral complications [1953], p. 170
 Treatment of the spinal complications [1953], p. 174
 Conclusions [1953], p. 176

Abstracts

- Surgical aspects of meningitis [1951], p. 320
 Neurosurgery in diagnosis and treatment of tuberculous meningitis [1952], p. 249
 Congenital dermal sinus associated with meningitis [1952], p. 249

- 234 **MOUTH AND PHARYNX—MALIGNANT DISEASE OF**

Article

- Maxilla—carcinoma of [1956], p. 33
 Introduction [1956], p. 33
 Definition [1956], p. 33
 Primary growths [1956], p. 33
 Secondary growths [1956], p. 33
 Responsibility for treatment [1956], p. 33
 The deformity of untreated tumours [1956], p. 33
 Incidence and pathology [1956], p. 34
 Proportional incidence of primary tumours [1956], p. 34
 Spread of the tumours [1956], p. 35
 Symptoms and signs [1956], p. 35
 Diagnosis [1956], p. 35
 Prognosis [1956], p. 36
 Treatment [1956], p. 36
 Maxillary antrum [1956], p. 36
 Ethmoid tumours [1956], p. 40
 Tumours of the nasal fossae, palate and alveolus [1956], p. 40
 Invasion of the maxilla by secondary carcinoma [1956], p. 41
 Rodent ulcers of the skin invading upper jaw [1956], p. 41
 Special technical considerations [1956], p. 41
 Control of haemorrhage [1956], p. 41
 Split-thickness grafting of internal mucosal defects [1956], p. 4
 The internal palatal and alveolar defect [1956], p. 43
 The external defect [1956], p. 43
 Joint consultation clinics [1956], p. 45
 Summary [1956], p. 45

Abstracts

- Massive roentgen therapy in inoperable oral cancer [1952], p. 250
 Combined radiotherapy and surgery [1952], p. 250
 Carcinoma of the hypopharynx [1953], p. 300
 Malignant tumours and their treatment [1953], p. 301
 Biopsy studies of cancer of the gums [1953], p. 301
 Epithelioma of the chin [1954], p. 271
 Carcinoma of floor of mouth [1954], p. 271
 Malignant disease of the upper jaw: treatment [1955], p. 277
 Chondrosarcoma of the maxilla: treatment [1955], p. 278
 Evolution of major surgery: relation between radiotherapy and surgery [1956], p. 297

Vol. 6

KEY NO.

235 **MUSCLE AND TENDON—DISEASES AND INJURIES**

Abstracts

Malignant tumours of skeletal muscle research into histogenesis [1956], p. 297

Pigmented villo-nodular tenosynovitis [1956], p. 297

236 **NECK—CELLULITIS**

No further references

237 **NECK—CUT THROAT**

Abstract

Fracture of the hyoid bone [1951], p. 321

238 **NECK—CYSTIC SWELLINGS OF**

Abstracts

Causation and treatment of branchial cysts [1951], p. 321

Branchial cysts: surgical treatment [1956], p. 298

239 **NECK—TUBERCULOUS GLANDS**

Abstract

Pathology and treatment of cervical or mesenteric lymphadenitis [1952], p. 250

240 **NEOPLASMS—INNOCENT AND MALIGNANT**

Abstracts

Modern methods of treating malignant disease [1951], p. 322

Latent carcinoma [1955], p. 279

Carcinoma of the mastoid cavity [1955], p. 279

Malignant synovioma: report on treatment of 3 cases [1955], p. 280

Dermoid tumours difficulties in diagnosis [1956], p. 298

Multiple neurofibromatosis disease groups and associated lesions [1956], p. 299

241 **NERVES—CRANIAL**

No further references

242 **NERVES, PERIPHERAL—INJURIES**

Abstracts

Ischaemic lateral popliteal nerve palsy; vascular disturbances associated with foot-drop [1955], p. 280

Two-stage operation involving minimal traction injury [1956], p. 299

243 **NEURALGIA—TRIGEMINAL, GLOSSOPHARYNGEAL**

Abstracts

Technique of alcohol injection of Gasserian ganglion [1951], p. 323

Review of treatment of trigeminal neuralgia [1952], p. 251

244 **NOSE, NASOPHARYNX AND ACCESSORY SINUSES**

Abstracts

Diagnosis and treatment of mucocoele of the sinuses [1951], p. 324

Malignant tumours of the nasopharynx [1952], p. 251

244 NOSE, NASOPHARYNX AND ACCESSORY SINUSES (cont.): *Abstracts (cont.)*

- Treatment of ulcerative destruction of the nose with chloramphenicol [1953], p. 301
- Chondrosarcoma: clinical picture and prognosis [1953], p. 302
- Intranasal encephaloceles: diagnosis and treatment [1953], p. 302
- Carcinoma of the nose: surgical treatment [1955], p. 280
- Frontal sinusitis: review of treatment by external surgery [1955], p. 281
- Maxillary sinusitis: treatment [1956], p. 300

245 ODONTOMES AND EPITHELIAL CYSTS *Abstracts*

- Diagnosis and treatment of maxillary cysts [1951], p. 324
- Epithelial cysts of the jaws: adamantinoma [1956], p. 300
- Multiple dental cysts [1956], p. 300

246 OEDEMA—TRAUMATIC *No further references*

247 OESOPHAGUS *Articles*

- Reconstruction of the trachea, hypopharynx and cervical oesophagus [1951], p. 193
- Cardiospasm [1953], p. 178
- Aetiology [1953], p. 178
- The physiology of the cardia [1953], p. 179
- Pathology [1953], p. 180
- Clinical features [1953], p. 180
- Radiological appearance [1953], p. 184
- Oesophageal appearances [1953], p. 186
- Treatment [1953], p. 186
- Complications [1953], p. 191
- Oesophagus—atresia [1956], p. 47
- Pathology [1956], p. 47
- Physiology [1956], p. 48
- Diagnosis [1956], p. 51
- Pre-operative management [1956], p. 51
- Prior to admission [1956], p. 51
- Resuscitation measures [1956], p. 52
- Reconstructive technique [1956], p. 52
- Anaesthesia [1956], p. 52
- Operation [1956], p. 52
- Post-operative care [1956], p. 54
- Circulation and fluid balance [1956], p. 57
- Respiration [1956], p. 57
- Feeding [1956], p. 58
- Post-operative complications [1956], p. 58
- Stenosis [1956], p. 58
- Anastomotic leakage [1956], p. 58
- Recurrent tracheal fistula [1956], p. 60
- Dysphagia without stenosis [1956], p. 60
- High intestinal ileus [1956], p. 60
- Bronchiectasis [1956], p. 60

247 OESOPHAGUS (*cont.*):

Articles (cont.):

Oesophagus—the surgical anatomy of competence at the cardia and its restoration in hiatus hernia [1956], p. 61

Importance of the correctly-functioning cardia [1956], p. 61

The mechanism of competence [1956], p. 61

The hiatal muscle [1956], p. 61

The ligaments of the cardia [1956], p. 62

The oblique gastric muscle and cardiac mucosa [1956], p. 64

The submucosa round the cardia [1956], p. 66

Function [1956], p. 66

Restoration of competence [1956], p. 67

Complications precluding successful reduction [1956], p. 67

Surgical repair of the cardia mechanism [1956], p. 67

Results [1956], p. 71

Critical survey

Carcinoma of the oesophagus [1954], p. 210

Anatomy [1954], p. 210

Pathology [1954], p. 211

Symptoms [1954], p. 212

Diagnosis [1954], p. 212

Differential diagnosis [1954], p. 213

Assessment of patient [1954], p. 214

Choice of operation [1954], p. 214

Palliative operation [1954], p. 214

Resection and reconstruction [1954], p. 214

Total gastrectomy and Roux Y oesophago-jejunostomy [1954], p. 215

Low thoracic oesophagogastrostomy [1954], p. 216

High thoracic oesophagogastrostomy [1954], p. 216

Results [1954], p. 216

Conclusions [1954], p. 216

Wookey operation [1954], p. 228

Results [1954], p. 228

Abstracts

Rupture of the oesophagus [1952], p. 252

Congenital abnormalities incidence [1952], p. 253

Atresia: prognosis and treatment [1952], p. 253

Simple tumours of the oesophagus [1952], p. 153

.....

.....

.....

.....

Regurgitant oesophageal ulcer: symptomatology and treatment [1956], p. 301

Carcinoma of the oesophagus palliative segmental resection [1956], p. 301

248 OMENTUM

Abstracts

Diagnosis and treatment of torsion of the omentum [1951], p. 326

Torsion of great omentum: surgical treatment [1952], p. 254

Vol. 6

NOTER-UP, 1956

KEY NO.

249 **OPTIC NERVE**

No further references

250 **ORBIT—INJURIES, INFECTIONS, NEOPLASMS**

Abstract

Tumours of the orbit [1951], p. 327

New
Heading **ORGAN TRANSPLANTATION**

Critical survey

Organ transplantation [1955], p. 204

Grafts and transplants [1955], p. 204

Definition of terms in current use in grafting [1955], p. 205

Kidney transplantation [1955], p. 205

A theory of the host-homotransplant relationship [1955], p. 209

Anuria—technical and immunological [1955], p. 209

Plasma cells and their significance [1955], p. 210

Histological features of second homotransplanted kidneys [1955], p. 211

The common antigenicity of tissues [1955], p. 211

Antibodies to homografted tissues in general [1955], p. 211

The transplanted adrenal [1955], p. 212

Heart transplantation [1955], p. 213

Lung transplantation [1955], p. 213

The future of organ transplantation [1955], p. 214

251 **ORTHODONTICS**

Abstract

Trends in orthodontic treatment [1951], p. 327

252 **ORTHODONTICS—SURGERY OF**

No further references

253 **ORTHOPTIC TRAINING**

No further references

254 **OVARY**

Abstracts

Carcinoma: review of a series [1952], p. 254

Carcinoma: vaginal metastases [1953], p. 303

Ovarian tumours: post-operative irradiation [1956], p. 302

Prognosis of primary ovarian cancer [1956], p. 302

Rhabdomyosarcoma of the ovary [1956], p. 302

255 **OXYGEN THERAPY**

No further references

256 **PAIN—CAUSALGIA**

No further references

Critical surveys

C.

- Diagnosis at operation [1955], p. 170
- Assessment of operability [1955], p. 171
- Infiltration of the body and the tail [1955], p. 171
- Carcinoma of the head of the pancreas [1955], p. 171
- Surgical treatment [1955], p. 172

Techniques of end col resect - 1955 - 172

74

- Obstruction of the pancreatic duct [1956], p. 250
- Vascular theory [1956], p. 250
- Trauma [1956], p. 251
- Miscellaneous [1956], p. 251
- Clinical aspects [1956], p. 251
- Treatment [1956], p. 252
 - Prevention or reduction of pancreatic enzyme production [1956], p. 252
 - Supportive therapy [1956], p. 253
 - Control of pain [1956], p. 253
 - Antibiotic therapy [1956], p. 253
 - Surgical treatment [1956], p. 253
- Recurrent or relapsing pancreatitis [1956], p. 254
- Summary [1956], p. 260

Abstracts

The meta-pancreatic pancreas [1953] - 204

- Carcinoma of the ampulla of Vater symptoms, signs and treatment [1953], p. 305
- Carcinoma of the pancreas radiological diagnosis [1953], p. 305
- Carcinoma of the head of the pancreas: treatment [1953], p. 306
- Total extirpation of the pancreas: end-results [1953], p. 306
- Islet-celled adenoma with hyperinsulinism. treatment [1953], p. 306
- Tumours. islet-cell adenoma causing hyperinsulinism [1954], p. 274
- Hyperinsulinism: treatment [1955], p. 282
- Carcinoma causing jaundice evaluation methods of diagnosis and treatment [1955], p. 283
- Pancreatitis: investigation of causative factors [1955], p. 283
- Changes observed in the duct in chronic pancreatitis [1955], p. 283
- Surgical aspects of pancreatitis [1955], p. 284
- Results of experimental production of pancreatitis [1955], p. 285

PANCREAS (cont.):*Abstracts (cont.):*

- Pancreatic cysts: diagnosis and treatment [1955], p. 285
 Pancreatic cyst: pancreatic fistula [1956], p. 303
 Pancreatography: investigation of 100 cases [1956], p. 303
 Acute pancreatitis: metabolic study [1956], p. 304
 Diagnosis of acute pancreatitis [1956], p. 304
 Islet cell tumour: clinical features and treatment [1956], p. 305

PARALYSIS—MANAGEMENT OF*Abstracts*

- Transplantation of the spinal cord in paraplegia [1951], p. 328
 Infantile hemiplegia treated by hemispherectomy [1952], p. 255
 Hemiplegia: treatment [1955], p. 286

PARATHYROID GLAND—DISEASES*Abstracts*

- Hyperparathyroidism: results of surgical treatment [1951], p. 329
 Hyperparathyroidism: differential diagnosis from sarcoidosis [1952], p. 256

PELLAGRA*No further references***PELVIC ORGANS—DISPLACEMENT***Critical survey*

- Stress incontinence [1951], p. 259
 Introduction [1951], p. 259
 Clinical findings [1951], p. 259
 Repair of defects in the urethral supports [1951], p. 259

Abstracts

- Stress incontinence in women with genital prolapse [1952], p. 256
 Stress incontinence: failure of cure following vaginal operative procedure [1952], p. 256

PELVIC ORGANS—VISCERECTOMY*Article*

- Introduction [1954], p. 131
 Indications [1954], p. 131
 Cancer of the uterus [1954], p. 131
 Cancer of large bowel [1954], p. 132
 Cancer of the bladder [1954], p. 132
 Cancer of the vulva and vagina [1954], p. 132
 Operability [1954], p. 134
 Extent of operation [1954], p. 134
 Anterior procedure [1954], p. 134
 Posterior procedure [1954], p. 134
 Total viscerectomy [1954], p. 134
 Management of the ureters [1954], p. 138
 Wet colostomy [1954], p. 138
 [368]

Vol. 6

KEY NO.

New
Heading

PELVIC ORGANS—VISCERECTOMY (cont.):

Article (cont.):

- Technique of pelvic viscerectomy [1954], p. 138
- Pre-operative investigations [1954], p. 138
- Anaesthesia [1954], p. 139
- Position of patient [1954], p. 139
- Abdominal phase [1954], p. 139
- Perineal-vulval phase [1954], p. 140
- Making of an artificial bladder [1954], p. 140
- The colostomy [1954], p. 142
- Early post-operative period [1954], p. 142
- Complications and sequelae [1954], p. 143
- Urinary fistulae [1954], p. 143
- Intestinal fistulae [1954], p. 143
- Mortality and end-results [1954], p. 146

262 PEPTIC ULCER AND ITS COMPLICATIONS

Article

- Gastric ulcer: the vascular anatomy of the human stomach in relation to [1952], p. 104

Abstracts

- Causation of peptic ulceration [1951], p. 330
- Hormonal overaction in relation to gastric secretion in chronic duodenal ulcer [1951], p. 330
- Banthine in the treatment of peptic ulcer [1951], p. 330
- Medical and surgical treatment of cases of peptic ulcer with gross bleeding [1951], p. 331
- Surgical treatment of intractable duodenal ulceration [1951], p. 331
- Bilateral transpleural vagotomy with vagus resection [1951], p. 332
- Gastroscopic and histological appearances before and after vagotomy [1951], p. 332
- Results of vagotomy in peptic ulcer [1951], p. 332
- Partial gastrectomy for peptic ulcer [1951], p. 333
- Subtotal gastric resection and bilateral vagotomy for gastric and duodenal ulcers [1951], p. 333
- Post-operative mortality and methods of partial gastrectomy [1951], p. 334
- Necropsy findings, innocent and malignant [1952], p. 257
- Medical and surgical treatment in general practice [1952], p. 257
- Surgical treatment for duodenal ulcer [1952], p. 258
- Gastric resection for duodenal ulcer [1952], p. 258
- Late results of resection for gastro-duodenal ulcer [1952], p. 258
- Results of vagotomy alone or combined with other operations [1952], p. 260
- Comparison between vagotomy and resection [1952], p. 260
- Chronic peptic ulcer: results of vagotomy [1952], p. 260
- Subsequent stricture and cardiospasm after oesophageal ulcer [1952], p. 261
- Achalasia cardiospasm [1952], p. 261
- Perforations end-results of operation [1952], p. 262
- Experimental transplantation of gastric tissue in prevention [1952], p. 262
- Gastro-jejunal ulceration: aetiology and treatment [1953], p. 307
- Gastro-jejunal ulceration: treatment by vagotomy [1953], p. 307

Vol. 6

KEY NO.

NOTER-UP, 1956

262 PEPTIC ULCER AND ITS COMPLICATIONS (cont.):
Abstracts (cont.):

- Gastrectomy and colonic replacement in treatment of gastric ulcer [1953], p. 308
- Gastrectomy: post-operative dumping syndrome [1953], p. 308
- Treatment of perforated gastric ulcer [1953], p. 308
- Gastric and duodenal: treatment [1953], p. 309
- Duodenal ulcer: vagotomy [1954], p. 275
- Benign and malignant gastric ulcers [1954], p. 275
- Haemorrhage [1954], p. 276
- Complicated gastric and duodenal ulcer [1954], p. 277
- Radical partial gastrectomy [1954], p. 277
- Duodenal and gastric ulcer: sex, racial and occupational distribution [1955], p. 286
- Relationship between levels of gastric and duodenal acidity [1955], p. 287
- Duodenal ulcer: surgical treatment [1955], p. 287
- Technique of subtotal gastrectomy for gastric ulcer [1955], p. 288
- Gastric ulcer: post-operative occurrence of pulmonary tuberculosis [1956], p. 305
- Gastric ulcer: cases referred for surgery [1956], p. 305
- Duodenal ulcer: perforation into pancreas [1956], p. 306
- Massive acute upper gastro-intestinal haemorrhage [1956], p. 306
- Surgical treatment of peptic ulcer [1956], p. 306

263 PERFORATING ULCER OF THE FOOT
No further references

264 PERITONEUM AND PERITONITIS
Article

- Appendicitis and peritonitis [1951], p. 32

Abstracts

- Ascites: diagnosis [1955], p. 288
- Biopsy specimens: Ruddock peritoneoscope and modified forceps [1955], p. 289
- Primary retroperitoneal tumours: incidence of specific types [1955], p. 28
- Acute chylous peritonitis: clinical appearances and treatment [1956], p. 30

Vol. 7

265 PHARYNGEAL DIVERTICULA
Abstracts

- Mechanism of herniation [1951], p. 334
- Pharyngo-oesophageal diverticulosis: surgical treatment [1953], p. 309

266 PHYSIOTHERAPY
Abstract

- Electromyography in orthopaedics [1951], p. 335

267 PHYSIQUE, BODY BUILD AND POSTURE
No further references

[370]

Vol. 7

KEY NO

268 **PITUITARY TUMOURS**

Abstract

Treatment: ACTH in conjunction with surgery [1955], p. 289

269 **PLASTIC SURGERY—CORNEAL GRAFTING**

Abstracts

Scope of corneal grafting [1954], p. 277

Partial penetrating keratoplasty [1954], p. 278

Collection and preservation of graft [1954], p. 278

Use of special punch in corneal grafting, technique [1955], p. 290

New **PLASTIC SURGERY—CORRECTION OF FACIAL DEFORMITY**

Heading *Article*

Plastic procedures [1956], p. 72

The Abbé operation [1956], p. 72

Indications [1956], p. 72

The operation [1956], p. 72

The bat or winged ear deformity [1956], p. 75

Indications for treatment [1956], p. 75

The operation [1956], p. 75

Dressing [1956], p. 77

Rhinophyma [1956], p. 79

Pathology [1956], p. 79

Operation [1956], p. 79

Post-operative treatment [1956], p. 79

Saddle nose [1956], p. 79

Causes [1956], p. 79

Indications for treatment [1956], p. 80

Treatment [1956], p. 81

270-273 **PLEURA—DISEASES OF**

Critical survey

Biological decortication (enzyme debridement) [1953], p. 235

..

1

Abstracts

Pleural cysts: development and treatment [1952], p. 263

Chronic pleural empyema treatment [1956], p. 307

274 **POLIOMYELITIS**

Articles

Poliomyelitis [1954], p. 147

General [1954], p. 147

The viruses [1954], p. 147

Active and passive immunity [1954], p. 148

Paralysis [1954], p. 148

Factors influencing paralysis [1954], p. 148

Inoculations [1954], p. 149

Operations [1954], p. 149

Differential diagnosis [1954], p. 149

Bulbar poliomyelitis [1954], p. 150

Development of paralysis [1954], p. 151

Organization of poliomyelitis unit for acute cases [1954], p. 151

Articles (cont.):

- Cases with paresis of respiration [1954], p. 152
- Prevention of atelectasis [1954], p. 152
- Failing respiration [1954], p. 153
- Mechanical respirator pumps [1954], p. 157
- Management of cases [1954], p. 158
- Nursing [1954], p. 159
- Physiotherapy [1954], p. 159
- Assessment of method [1954], p. 159
- Treatment of poliomyelitis [1954], p. 162
- Pathology in relation to treatment [1954], p. 162
- Changes in central nervous system [1954], p. 162
- Anconal changes [1954], p. 162
- Changes in muscle [1954], p. 163
- Sensory and irritative phenomena [1954], p. 163
- Deformity [1954], p. 165
- Recovery [1954], p. 167
- Prognosis [1954], p. 169
- Treatment [1954], p. 169
- Early treatment [1954], p. 171
- Treatment for return of voluntary power [1954], p. 173
- Rehabilitation and resettlement [1954], p. 180
- Conditions at home [1954], p. 180
- Transport [1954], p. 180
- Occupation [1954], p. 181
- Grossly handicapped patients [1954], p. 181
- Children [1954], p. 182
- Welfare organization [1954], p. 182
- Poliomyelitis: the distribution of the paralysis [1956], p. 83
- Muscle paralysis in the acute and convalescent stages [1956], p. 83
- The initial paralysis [1956], p. 83
- Muscle testing [1956], p. 83
- Recovery of paretic muscles [1956], p. 84
- Recovery of paralysed muscles [1956], p. 85
- Clinical distribution of the permanent paralysis [1956], p. 86
- The limbs [1956], p. 86
- Paresis and paralysis in the lower limb [1956], p. 86
- Method [1956], p. 89
- Results—muscles below the knee [1956], p. 90
- Results—muscles above the knee [1956], p. 92
- The pathological basis of the muscle paralysis [1956], p. 94
- Segmental innervation in relation to affection or paralysis of muscles [1956], p. 94
- The spinal cord in the normal and poliomyelitis [1956], p. 95
- Method of study [1956], p. 96
- Motor cell columns of the lumbo-sacral spinal cord [1956], p. 97
- Representation of the muscles of the lower limb in the motor cell columns [1956], p. 97

Vol. 7

KEY NO.

274 POLIOMYELITIS (cont.):

Poliomyelitis: the distribution of the paralysis (cont.).

The spinal cord in the normal and poliomyelitis (cont.)

Sites of motor cell destruction in poliomyelitis [1956], p. 97

Relationship between the distribution of the paralysis and the destruction of motor nerve cells [1956], p. 99

Associated paralysis [1956], p. 100

Patterns of paralysis in the lower limb [1956], p. 101

Prognosis [1956], p. 101

Prognosis [1956], p. 102

Convalescent stage [1956], p. 102

Muscle imbalance [1956], p. 102

Anticipation of deformity [1956], p. 103

Abstracts

Muscle recovery: tests on 149 patients suffering from paralytic poliomyelitis [1955], p. 290

Abductor paralysis of shoulder value of splinting [1956], p. 305

275 POLYCYSTIC DISEASE

Abstracts

Unilateral polycystic kidney disease [1951], p. 335

Renal lesions in the child aetiology [1952], p. 263

276 POST-OPERATIVE GANGRENE

No further references

277 PREGNANCY—SURGICAL INTERVENTION DURING

Abstracts

Indications: assessment of risks [1951], p. 336

Management of ectopic pregnancy [1953], p. 310

278 PROSTATE

Abstracts

Prostatectomy [1952], p. 264

Prostatectomy [1952], p. 264

Prostatectomy [1952], p. 264

Prostatectomy [1952], p. 264

Prostatectomy [1952], p. 264

Prostatectomy [1952], p. 264

Prostatectomy [1952], p. 264

Prostatectomy [1952], p. 264

Prostatectomy [1952], p. 264

Prostatectomy [1952], p. 264

Prostatectomy [1952], p. 264

Prostatectomy [1952], p. 264

Prostatectomy [1952], p. 264

Prostatectomy [1952], p. 264

Prostatectomy [1952], p. 264

Prostatectomy [1952], p. 264

Prostatectomy [1952], p. 264

Prostatectomy [1952], p. 264

Prostatectomy [1952], p. 264

Prostatectomy [1952], p. 264

Endocrine therapy in carcinoma of the prostate [1955], p. 291

Adrenalectomy in carcinoma of the prostate [1955], p. 291

Clinical results of a series of cases of carcinoma of the prostate [1955], p. 292

Techniques of prostatectomy treatment according to type of obstruction [1955], p. 292

Vol. 7

KEY NO

278 PROSTATE (*cont.*):

Abstracts (cont.):

- Prostatic obstruction: surgical management [1955], p. 293
- Prostatic median bar: transurethral resection [1956], p. 308
- Carcinoma of prostate: orchidectomy and stilboestrol therapy [1956], p. 308
- Radical retropubic prostatectomy [1956], p. 309
- Morbidity associated with retropubic prostatectomy [1956], p. 309
- Suprapubic prostatectomy: morbidity [1956], p. 310
- Transurethral resection: morbidity [1956], p. 310

279 PROTRACTED ILLNESS—MANAGEMENT AND REHABILITATION

No further references

280 PULMONARY ABSCESS

No further references

281 PULMONARY TUBERCULOSIS

Abstracts

- Standard lung dissection operations in children [1952], p. 267
- Late results of thoracoplasty [1952], p. 267
- Pneumonectomy and immediate thoracoplasty: technique [1953], p. 311
- Development of haemothorax following artificial pneumothorax refill [1953], p. 311
- Treatment: age considerations in relation to thoracoplasty [1955], p. 293
- Segmental and wedge resection, lobectomy and pneumonectomy in treatment of pulmonary tuberculosis [1956], p. 310

282 PYLEPHLEBITIS

No further references

283 PYLORIC STENOSIS OF INFANTS

Abstract

- Theory of post-natal development [1952], p. 268

284 RABIES

No further references

285 RADIOACTIVE ISOTOPES

Critical survey

- Clinical uses of radioactive isotopes [1951], p. 237

Abstract

- Radioactive phosphorus in determining limits of spread of cerebral gliomas [1951], p. 285

286 RADIOTHERAPY

Abstracts

- Bone tumours [1954], p. 280
- 30 MeV synchrotron [1954], p. 280
- Radiation sickness: treatment [1955], p. 294

287-288 RECONSTRUCTION OF THE EAR AND NOSE

Abstract

- Rhinoplastic reconstruction: the role of the septum [1951], p. 340 [374]

Vol. 7

KEY NO.

289 RECTUM—BENIGN TUMOURS OF

Abstracts

Diffuse familial polyposis of the colon [1952], p. 269

Villous tumours: radical approach in treatment [1956], p. 311

290 RECTUM—CARCINOMA OF

Article

Restorative resection of the rectum [1952], p. 87

Abstracts

Perineal dissection in excision [1952], p. 269

Excision combined with colostomy post-operative obstruction of the small intestine [1952], p. 269

Treatment, radical surgery and radiotherapy [1954], p. 280

Submucosal rectal carcinoids incidence and treatment [1955], p. 294

291 RECTUM—HAEMORRHOIDS

Abstract

Haemorrhoidectomy [1954], p. 281

292 RECTUM—PROCTITIS

No further references

293 RECTUM—PROLAPSE

Article

The treatment of rectal prolapse [1956], p. 104

Partial prolapse [1956], p. 104

Prolapse in infancy [1956], p. 104

Partial prolapse in adults [1956], p. 104

Complete rectal prolapse [1956], p. 105

Conditions present in complete rectal prolapse [1956], p. 105

Abdominal operations for rectal prolapse [1956], p. 110

Anterior resection for complete rectal prolapse [1956], p. 110

Conclusion [1956], p. 114

Abstracts

Treatment for massive prolapse [1953], p. 312

Oil-soluble anaesthetics and lasting analgesia [1953], p. 312

Treatment, surgical treatment [1954], p. 281

294 REFRIGERATION ANAESTHESIA

Critical survey

Hypothermic anaesthesia [1956], p. 177

Cardiovascular surgery [1956], p. 177

Direct repair under vision of cardiac abnormalities [1956], p. 177

Operations on the great vessels [1956], p. 177

Operations for congenital cyanotic heart disease [1956], p. 177

.....

..

The advantages accruing from the hypothermic state [1956], p. 178

Reduced oxygen requirement [1956], p. 178

Reduced cardiac activity [1956], p. 178

Increased coagulation time [1956], p. 178

Reduced anaesthetic requirements [1956], p. 179

Vol. 7

KEY NO.

294 REFRIGERATION ANAESTHESIA (cont.):

Hypothermic anaesthesia (cont.):

Dangers of the method [1956], p. 179

The cold stress response [1956], p. 179

Tissue injury due to cold [1956], p. 179

Effects on vital organs [1956], p. 179

Changes in the blood [1956], p. 180

The elimination of non-volatile anaesthetic agents [1956], p. 180

Cardiovascular system [1956], p. 181

After-cooling [1956], p. 183

..... 184

..... 184

Body cavity cooling [1956], p. 186

Extra-corporeal bloodstream cooling [1956], p. 186

295 RESUSCITATION

No further references

296 RETINA

Article

Retinal detachment: improvements in investigation and treatment [1953], p. 224

Ophthalmoscopy [1953], p. 224

Abstract

Diathermy and antibiotics in simple detachment [1952], p. 270

297 SACRO-COCYGEAL REGION—SURGERY OF

Abstract

Sacro-coccygeal pilonidal cyst [1951], p. 342

298 SALIVARY GLANDS

Article

..... 118

..... 118

..... 118

..... 118

..... 118

..... 118

..... 118

..... 118

..... 118

..... 118

..... 118

..... 118

..... 118

..... 118

..... 118

..... 118

..... 118

..... 118

..... 118

..... 118

..... 118

Abstracts

..... of the parotid gland [1951], p. 342

..... 343

..... 343

..... 343

..... 343

..... 343

..... 343

..... 343

..... 343

Parotid gland: fatty infiltration simulating malignancy [1956], p. 311

Sialoangiectasis of the parotid glands [1956], p. 312

Acute suppurative parotitis: treatment [1956], p. 312

Vol. 7

KEY NO

299 SCALP AND SKULL

No further references

300 SCHISTOSOMIASIS

No further references

301 SCIATICA

No further references

302 SCLERA

No further references

303 SCURVY—MASKED AND MANIFEST

No further references

304 SKIN—DISEASES OF, IN RELATION TO SURGERY

Abstracts

Pilonidal disease: diagnosis and treatment [1955], p. 295

Staphylococcal skin infections: infrequency of satisfactory cure [1955], p. 295

305 SPEECH THERAPY

No further references

306 SPINAL COLUMN

Articles

Spondylolisthesis [1951], p. 174

Spinal column—traumatic paraplegia: problems of diagnosis and early treatment [1956], p. 133

Early effects of injury to the spinal cord [1956], p. 133

Injury to nerve roots [1956], p. 133

Period of suppression of function [1956], p. 133

Diagnosis [1956], p. 134

Distinction between cord and root lesion [1956], p. 134

Total temporary suppression of function (spinal shock) [1955], p. 135

138

144

144

144

144

Abstracts

Mechanism of cervical radicular lesions [1952], p. 270

Compression of cervical nerve roots [1952], p. 271

1952, p. 271

1952, p. 271

1952, p. 271

1952, p. 271

1952, p. 271

1952, p. 271

and results of operation

[1952], p. 271

Vol. 7

KEY NO.

306 SPINAL COLUMN (*cont.*):

Abstracts (cont.)

- Electromyograms in cases of post-operative pain due to stretch injury [1952], p. 272
- Complete dislocation of thoracic spine [1953], p. 312
- Fracture-dislocation: clinical picture [1953], p. 312
- Spondylolisthesis: symptomatology [1955], p. 295
- Scoliosis: treatment [1955], p. 296
- Wedge resection in the correction of scoliosis [1955], p. 296
- History and treatment of scoliosis [1955], p. 297
- Calvé's disease: due to eosinophilic granuloma [1955], p. 297
- Osteochondritis of the lumbar spine: diagnostic features [1955], p. 297
- Traumatic paraplegia: results of late laminectomy [1956], p. 312
- Vertebral osteochondritis: pathology, clinical symptoms and treatment [1956], p. 313

307 SPINAL CORD

Abstracts

- Compression paraplegia: rare causes and treatment by laminectomy [1952], p. 272
- Lumbar and sacral cysts [1952], p. 273
- Surgical treatment of pain [1952], p. 273
- Intramedullary lipoma [1954], p. 282
- Pott's paraplegia: treatment [1955], p. 298
- Myelocoele and meningocele: follow-up of 5 cases [1955], p. 298
- Spinal canal dilatation at thoraco-lumbar junction [1956], p. 313
- Tumours: compression of spinal cord [1956], p. 313

Vol. 8

308 SPLEEN—SURGERY OF

Abstracts

- Indications for porta-caval shunt in splenic anaemia [1952], p. 274
- Porta-caval, spleno-renal and other venous shunts in splenic anaemia [1952], p. 274
- Kala-azar: effects and treatment by splenectomy [1952], p. 274
- Diagnostic radiology in visualization of splenic and portal circulation [1953], p. 313
- Malignant tumour of the spleen [1953], p. 313
- Banti's syndrome: diagnosis [1953], p. 313
- Essential thrombocytopenic purpura: treatment by splenectomy [1953], p. 314
- Splenectomy: indications and technique [1953], p. 314
- Splenectomy: anatomical and physiological considerations [1953], p. 314
- Banti's disease: portal venography in the demonstration of veins suitable for anastomosis [1955], p. 299

[1956], p. 314

309-310 STERILITY AND STERILIZATION

No further references

Vol. 8

KEY NO.

311 STERILIZATION OF SURGICAL APPARATUS

Abstracts

Sterilization of operating-room by means of antibiotics [1951], p. 348
Bactericides: benzchlorophenol [1952], p. 275

312 STOMACH—DISEASES OF

Critical survey

Carcinoma of the stomach [1954], p. 232
Diagnosis of gastric cancer [1954], p. 232
Symptoms [1954], p. 232
A method of diagnosis [1954], p. 232
Aids to diagnosis [1954], p. 232
Summary [1954], p. 234
Gastric resection for cancer of the stomach [1954], p. 235
Pre-operative management of patient [1954], p. 235
Operative technique [1954], p. 235
Total versus partial resection [1954], p. 235
Carcinoma of pyloric end of stomach [1954], p. 235
Mid-gastric carcinoma [1954], p. 237
Carcinoma of upper stomach [1954], p. 237
Irremovable obstructed cancer of upper stomach [1954],
p. 238
Results of treatment [1954], p. 240

Abstracts

Indications for gastrectomy and for vagotomy [1951], p. 348
Gastro-intestinal lymphosarcoma [1951], p. 349
Gastric obstruction resulting from the swallowing of corrosive poison
[1952], p. 275
Tumours surgical methods of treatment [1953], p. 315
Clinical history of carcinoma and results of resection [1953], p. 315
Gastric operations [1954], p. 282
Benign gastric tumours diagnosis [1956], p. 315

313 STRABISMUS AND HETEROPHORIA

Abstract

Esophoria surgical treatment [1952], p. 276

STRESS INCONTINENCE, *see* Pelvic Organs

314 SUBPHRENIC ABSCESS

Abstracts

Spread of infection to chest [1956], p. 315

315 SUPRASPINATUS LESIONS

No further references

316 SURGICAL TECHNIQUE

Abstracts

Control of the circulation with hypotensive drugs and by posture [1951], p. 350

Fortisan as a suture material [1951], p. 351

Use of cortisone and ACTH: effect on healing [1953], p. 316

317 SURGICAL TECHNIQUE—WOUND DRESSINGS

No further references

318 SYPHILIS

No further references

319 TABES DORSALIS (LOCOMOTOR ATAXIA)

Abstract

Treatment: results of surgical intervention [1954], p. 284

320 TESTICLE AND TUNICA VAGINALIS

Abstracts

Histology of testicular tissues and tumours and isolation of ketosteroids [1952], p. 276

Cholesteatoma of epididymus [1952], p. 277

Radiotherapy after orchidectomy [1952], p. 277

Tumours of spermatic cord: primary or secondary [1952], p. 277

Epididymis: sarcoma [1954], p. 273

Germinal tumour of the testis: relationship of interstitial cell hyperplasia to urinary gonadotrophins, testicular atrophy and histological type [1955], p. 299

Imperfect descent of the testis: treatment [1955], p. 300

Tumour of the vas deferens: clinical findings [1955], p. 300

Primary carcinoma of the epididymis: diagnosis and treatment [1955], p. 301

Tuberculous epididymitis: treatment [1955], p. 301

Metaplasia: pathology [1955], p. 301

Adenocarcinoma of the excretory ducts: occurrence in maldescended testicle [1955], p. 302

Epididymitis: combined therapy [1956], p. 316

Imperfect descent of the testicle [1956], p. 316

321 TETANUS

Abstracts

Immunization: duration of vaccine immunity [1955], p. 302

Treatment: tracheotomy and positive pressure ventilation [1955], p. 303

322 TETANY

Abstract

Relation to potassium deficiency: experimental observations [1955], p. 303

323 THORACIC AND INTRATHORACIC INJURIES

Abstracts

Angiocardiography, intrathoracic, to display foreign bodies [1952], p. 278

Injuries to the parietes: method of reuniting ribs [1953], p. 317

Crush injuries of the chest: surgical management [1955], p. 304

Vol. 8

KEY NO.

New **THORAX—CONGENITAL DEFORMITIES**

Heading Article

- Thorax—congenital deformities [1956], p 150
 - Funnel chest (pectus excavatum) [1956], p. 150
 - Aetiology [1956], p. 150
 - 150
 - Special investigations [1956], p 154
 - Indications for correction [1956], p. 154
 - Anaesthesia [1956], p 155
 - Operative technique [1956], p. 156
 - Post-operative care [1956], p. 159
 - Post-operative complications [1956], p 159
 - Results [1956], p 159
- Deficiencies of the chest wall [1956], p. 160
 - Definition [1956], p 160
 - Aetiology [1956], p 160
 - Clinical signs [1956], p 160
 - Indication for repair [1956], p. 161
 - Technique of repair [1956], p 161
 - Results [1956], p. 161

324 **THROMBOSIS AND EMBOLISM**

Abstracts

- Thrombosis and embolism [1956], p. 161
- Thrombosis of the common carotid artery [1956], p. 161
- Thrombosis of the common carotid artery [1956], p. 161

325 **THYMUS GLAND**

Abstracts

- Thymectomy: indications and assessment of results [1951], p. 353
- Radiographic procedures in diagnosis of tumours [1953], p 317

326 **THYROGLOSSAL CYST, SINUS AND FISTULA**

No further references

327 **THYROID GLAND—DISEASES OF**

Article

- Thyroiditis [1955], p. 148
 - Definition and nomenclature [1955], p 148
 - Acute thyroiditis [1955], p. 148
 - Clinical picture [1955], p 148
 - Differential diagnosis [1955], p. 148

327 THYROID GLAND—DISEASES OF (cont.):

Thyroiditis (cont.):

Acute thyroiditis (cont.):

Complications [1955], p. 149

Treatment [1955], p. 149

Hashimoto's thyroiditis [1955], p. 149

Pathology [1955], p. 150

Clinical picture [1955], p. 152

Complications [1955], p. 155

Treatment [1955], p. 156

De Quervain's thyroiditis [1955], p. 156

Clinical picture [1955], p. 156

Differential diagnosis [1955], p. 157

Pathology [1955], p. 157

Treatment [1955], p. 157

Riedel's thyroiditis [1955], p. 158

Clinical picture [1955], p. 158

Differential diagnosis [1955], p. 159

Pathology [1955], p. 159

Treatment [1955], p. 159

Abstracts

Lateral aberrant cancer [1952], p. 281

Posterior mediastinal goitre [1952], p. 281

Thyroiditis, needle biopsy in differential diagnosis [1952], p. 282

Diagnosis with radioactive iodine [1952], p. 282

Types of thyrotoxicosis and their management [1952], p. 282

Use of thiouracil in increasing uptake of radio-iodine absorption [1952], p. 283

Radio-iodine in the treatment of carcinoma [1952], p. 283

Radioactive iodine as an adjunct to surgery [1952], p. 284

Carcinoma of the thyroid: a review of 100 cases [1952], p. 284

Aetiology [1954], p. 284

Treatment [1954], p. 285

Adenoma and carcinoma [1954], p. 286

Carcinoma of the thyroid, classification and review of 190 cases [1955], p. 305

Carcinoma of the thyroid: a review of 100 cases [1955], p. 306

Carcinoma of the thyroid: a review of 100 cases [1955], p. 306

Carcinoma of the thyroid: a review of 100 cases [1955], p. 306

Carcinoma of the thyroid: a review of 100 cases [1955], p. 306

Carcinoma of the thyroid: a review of 100 cases [1955], p. 306

Carcinoma of the thyroid: a review of 100 cases [1955], p. 306

Carcinoma of the thyroid: a review of 100 cases [1955], p. 306

Carcinoma of the thyroid: a review of 100 cases [1955], p. 306

Carcinoma of the thyroid: a review of 100 cases [1955], p. 306

Carcinoma of the thyroid: a review of 100 cases [1955], p. 306

Carcinoma of the thyroid: a review of 100 cases [1955], p. 306

Carcinoma of the thyroid: a review of 100 cases [1955], p. 306

Carcinoma of the thyroid: a review of 100 cases [1955], p. 306

Carcinoma of the thyroid: a review of 100 cases [1955], p. 306

Carcinoma of the thyroid: a review of 100 cases [1955], p. 306

Carcinoma of the thyroid: a review of 100 cases [1955], p. 306

Carcinoma of the thyroid: a review of 100 cases [1955], p. 306

Carcinoma of the thyroid: a review of 100 cases [1955], p. 306

Carcinoma of the thyroid: a review of 100 cases [1955], p. 306

Carcinoma of the thyroid: a review of 100 cases [1955], p. 306

328 TONSILLITIS

No further references

329 TROPICAL DISEASE—SURGERY IN

Abstract

Treatment of ulcers [1952], p. 285

[382]

Vol. 8

KEY NO.

330 TUBERCULOSIS

Abstracts

Comparative merits of measures for detecting the tubercle bacillus [1951], p. 355

The Mantoux tuberculin test in diagnosis: negative reactions [1951], p. 355

Streptomycin treatment in genito-peritoneal tuberculosis [1951], p. 355

331 TYPHOID FEVER—SURGERY IN

No further references

332 ULCERS AND ULCERATION

Abstract

Rodent ulcer of neck, trunk and limbs [1951], p. 356

333 UMBILICUS—DISEASES OF

No further references

334 URAEMIA

Abstracts

Management of anuria [1951], p. 356

Peritoneal lavage in acute anuria [1951], p. 357

A new type of artificial kidney [1952], p. 286

335 URETER—TRANSPLANTATION OF

Article

Ureter—transplantation into the ileum [1956], p. 162

Principles of urinary diversion [1956], p. 162

Bilateral cutaneous ureterostomy [1956], p. 162

Uretero-colic anastomosis [1956], p. 162

Artificial bladder [1956], p. 163

Physiological and pathological consequences of urinary diversion into the intestine [1956], p. 163

Changes consequent upon uretero-colic anastomosis [1956], p. 164

Changes consequent on the incorporation of the ileum into the urinary tract [1956], p. 165

Indications for the construction of an ileal bladder [1956], p. 166

Spina bifida [1956], p. 166

For vesico-vagino-rectal fistula resulting from radiotherapy [1956], p. 166

In cases of pelvic exenteration for extensive pelvic cancer [1956], p. 166

Untreated ectopia vesicae in adults with grossly impaired renal function [1956], p. 166

Following cystectomy for carcinoma of the bladder [1956], p. 167

Choice of method [1956], p. 167

The operation [1956], p. 168

Preparation of the patient [1956], p. 168

The incision [1956], p. 168

Division of the ileum [1956], p. 168

335 URETER—TRANSPLANTATION OF (cont.):

Ureter—transplantation into the ileum (cont.):

The operation (cont.):

Division of the ureters [1956], p. 169

Anastomosis [1956], p. 170

The ileostomy stoma [1956], p. 170

Complications [1956], p. 172

Collection of urine [1956], p. 173

Late results [1956], p. 174

Ileal bladder as a reservoir [1956], p. 175

Abstracts

Operative technique [1952], p. 287

Cord bladder: management [1954], p. 286

Ileo-cystoplasty [1954], p. 286

Polythene catheters [1954], p. 287

Uretero-sigmoidostomy: post-operative complications [1956], p. 320

Uretero-sigmoidostomy: post-operative complications [1956], p. 320

336 URETHRA AND BLADDER—CONGENITAL MALFORMATIONS

Abstracts

Neonatal obstruction: diagnosis [1956], p. 321

337 URETHRA—NEW GROWTHS AND STRICTURE

Abstracts

Primary carcinoma of the male urethra: prognosis [1955], p. 308

Condylomata acuminata: clinical picture and treatment [1955], p. 309

Non-gonococcal or abacterial urethritis: differential diagnosis [1955], p. 309

338 URINARY ANTISEPTICS

Abstracts

Bacterial sensitivity in urinary infections [1952], p. 287

Treatment of urinary infections: results in a series of over 1,000 cases [1955], p. 309

339 UTERUS—FIBROIDS

Abstracts

A technique for vaginal hysterectomy [1951], p. 361

History of Wertheim's operation [1951], p. 362

Hysterectomy and abdominal colporrhaphy [1952], p. 237

Vol. 8

KEY NO

340 UTERUS—CARCINOMA OF THE BODY

Abstracts

.....

Cytological diagnosis [1952], p. 288

Radioactive colloidal gold in localization [1952], p. 288

Prognosis in vaginal metastases [1952], p. 288

341 UTERUS—CERVIX; AND VAGINA

Abstracts

Radium therapy of malignant lesions of the vagina [1951], p. 364

Treatment of cervical carcinoma [1953], p. 317

Carcinoma of the cervix: radiotherapy [1955], p. 310

Response to irradiation of the cervix [1955], p. 310

.....

p. 312

Carcinoma of the cervix: reappearance 30 years after treatment [1956], p. 321

342 UVEAL TRACT

No further references

343 VASCULAR SURGERY

Article

Surgery of the heart [1952], ■ 71

Congenital heart disease [1952], p. 71

Acquired heart disease [1952], p. 80

Critical survey

Chronic oedema of the leg [1952], p. 188

Abstracts

Vascular grafts: viability of canine aortic transplant [1952], p. 289

Blood-vessel bank [1952], ■ 289

Aortic coarctation: treatment by grafting [1952], p. 290

Aortic coarctation: results of treatment [1952], p. 290

Pulmonary stenosis: kymography and catheterization [1952], p. 290

Commissurotomy in mitral stenosis [1952], ■ 291

Finger-fracture valvuloplasty in mitral stenosis [1952], p. 291

Results of commissurotomy [1952], p. 291

.....

.....

[1953], p. 319

Aortic diseases [1954], p. 287

.....

.....

Human aortic homografts for arteriosclerotic aneurysms and thrombo-obliterative disease: structural changes [1955], p. 312

Aortic stenosis: treatment [1955], p. 313

Thrombo-obliterative disease of the aorta: surgical treatment [1955], p. 313

Acquired tricuspid stenosis: clinical diagnosis and treatment [1956], p. 322

[385]

Vol. 8

KEY NO.

343 VASCULAR SURGERY (*cont.*):

Abstracts (cont.):

- Atrial septal defects: operative repair under direct vision [1956], p. 322
- Coarctation of the aorta: criteria for surgical treatment [1956], p. 323
- Tetralogy of Fallot: treatment [1956], p. 323
- Intracardiac surgery: pre-operative assessment and post-operative management [1956], p. 323

344 VEINS—VARICOSE

Abstracts

- Gravitational ulcer: clinical picture and treatment [1955], p. 314
- Management of varicose veins: conservative and surgical treatment [1956], p. 324

345 VISCEROPTOSIS

No further references

346 VISUAL FIELDS—PERIMETRY AND INTERPRETATION

No further references

347 VITAMINS AND NUTRITION IN RELATION TO SURGERY

Abstracts

- Fat supplements [1954], p. 289
- Malnutrition in surgical patients: treatment [1955], p. 314

348 VITREOUS—INJURIES AND DISEASES

No further references

349 VOLVULUS

No further references

350 YAWS

Article

- Yaws—Skeletal manifestations [1955], p. 136
- Aetiology [1955], p. 136
- Clinical picture [1955], p. 136
- Bone lesions [1955], p. 136
- Differential diagnosis [1955], p. 144
- Treatment [1955], p. 147

Abstract

- Antibiotic therapy [1952], p. 292

INDEX

A

- Abbé operation, 72-75
 indications, 72
 principle of, 72
 technique, 73-75
- Abdomen, gunshot wounds of, 286
- ACTH in adrenal gland surgery, 263-264
- Adrenal glands,
 ACTH, cortisone and hydrocortisone in
 surgery of, 263-264
 neuroblastoma in childhood, 264
- Anaesthesia,
 caesarean sections and vaginal deliveries,
 for, 265-266
 general anaesthesia for, 155-156
- Advantages of, 170-172, 409
 after-cooling in, 183
 anaesthetic requirements, reduced, in,
 179, 181
 aortic grafting procedures, for, 178
 arrhythmias during, 181
 arteriovenous cooling, by, 186
 blankets, cooling, by, 184-185
 blood changes in, 180
 blood pressures during, 181
 body cavity cooling, by, 186
 cardiac activity and, 178
 cardiac output during, 181
 cardiovascular changes during, 181-183
 cardiovascular surgery, in, 177
 coagulation time, changes in, 178, 180
 cold stress response in, 179
 complications of, 265
 congenital cyanotic heart disease, oper-
 ations for, 177
 dangers of method, 179
 effects on vital organs, 179
 electrocardiographic control during, 181
 electrolyte changes in, 180
 extra-corporeal bloodstream cooling,
 by, 186
 glucose metabolism and, 181
 great vessels, operations on, for, 177
 indications, 177-178, 265
 methods of inducing, 184-187
 neurosurgery, in, 178
 non-volatile anaesthetic agents, elimina-
 tion of, and, 180-181
 oxygen requirement in, 178
 oxyhaemoglobin dissociation in, 180
 position of patient, changes during
 cooling, 183
 principle of, 177
 prostigmine, use during, 182-183

Anaesthesia—continued

hypothermic—continued

- relaxants, alteration in response to, 181
 re-warming after, 186

- surface cooling, by, 184-186
 temperature observations during, 183,
 184
 time available for operation through,
 183
 tissue injury due to cold in, 179
 venous cooling, by, 186-187
 ventricular fibrillation due to, 181-182
 treatment, 183

Aneurysm,

- abdominal aorta, of, 266
 ruptured, treatment, 266
 surgical treatment, 266-267
- axillary artery, of, 267
- intracranial, 1-3
 carotid artery, of, 2, 3, 10, 11
 diagnosis, 9-13
 incidence, 2
 origin, 2
 prognosis, 18
 radiographic appearance, 3, 4, 6, 7, 10,
 11, 12
 rupture, mechanism of, 2
 sites, 2
 size and shape, 3
 treatment, 20-26, 274
 carotid artery ligation, 20-22
 summary of methods, 26
 surgery of aneurysm itself, 22-26
 routes, 23-24
 technique, choice of, 25-26
 time for operation, 19-20
- renal artery, of, removal without neph-
 rectomy, 267

- Angina pectoris, stellate ganglion block, and,
 266

Angiography, cerebral, 16-17 vertebral, 17

Angiomas, intracranial, 3

- diagnosis, 13
 indications for surgery, 26, 28-29
 prognosis, 18-19
 treatment, 27-31
 epilepsy due to, 27
 morbidity, 27
 radical excision, 29
 radiotherapy, 29
 symptomatic, 29-31

INDEX

- Ankle,
 - acute inversion sprains, follow-up of cases, 281
 - injuries, osteochondritis dissecans following, 268
- Ano-rectal fistula, 280
- Anus, melanomas of, 247
- Aorta,
 - aneurysm, 266 (*see also* Aneurysm)
 - coarctation, indications for surgical treatment, 232
 - grafting procedures under hypothermic anaesthesia, 178
- Arteriography, renal, 268
- dangers, 268
- Arthrodesis of hips, avoidance of post-operative complications, 268-269
- Atresia, oesophageal, 47-60 (*see also* Oesophagus)
- Atrial septal defects, operative repair under direct vision, 322
- Axillary artery, aneurysm, 267

B

- Bedsore in paraplegia, 143-144, 146
- Bladder,
 - artificial, 163 (*see also* Ureter, transplantation)
 - tumours, treatment,
 - cobalt-bomb radiation, 269
 - nylon tube sutures of cobalt, 270
 - reimplantation of ureter after, 270
 - ureteric transplantation for, 162-176 (*see also* Ureter)
- Bones,
 - benign giant-cell tumour of femur, metastasis to lungs, 271-272
 - liposarcoma of the femur, 272
 - malignant cells in bone marrow aspiration, 271
 - osteogenic sarcoma, 271
- Brain,
 - abscess of otitic origin, 272
 - spontaneous haemorrhage, 1-32
- Branchial cysts, surgical treatment, 298
- Breast, carcinoma, methods of spread, 274
- Bronchiectasis, results of treatment by resection, 274-275
- Bronchus,
 - carcinoma, thrombosis, and, 317
 - foreign bodies, 279
- Burns, amino-acid loss in urine in, 275

C

- Caesarean section, anaesthesia for, 265
- Calcaneus, fractured, treatment of, 280
- Cardiovascular surgery, place of hypothermic anaesthesia in, 177
- Carotid artery ligation, 20-22
 - choice of artery, 21-22
 - dangers of, 20-21
 - hemiplegia due to, 21
 - indications for, 20
 - technique, 22

- Carr's stones, 190
- Cerebrovascular disease, intracranial haemorrhage due to, 5, 13
- Cervix, recurrence of carcinoma, 321-322
- Chest wall, deficiencies of, 160-161
 - aetiology, 160
 - clinical signs, 160
 - definition of, 160
 - indication for repair, 161
 - results of treatment, 161
 - treatment, technique, 161
- Cholangitis, choleduodenostomy in treatment of, 284
- Cholelithiasis, recurrence after cholecystectomy, 285
- Coagulation time, hypothermic anaesthesia, and, 178
- Cold stress response in hypothermic anaesthesia, 179

- Colitis,
 - segmental, 276-277
 - ulcerative,
 - results of biopsy of the rectum, 275
 - surgical treatment, 276
- Colon,
 - polyps of, malignancy, 277
 - sigmoid, artificial bladder as, 163
- Conjunctiva, emergency treatment of foreign bodies, 279
- Cordopexy in laryngeal paralysis, 227-230 (*see also* Larynx, paralysis)
- Coronary disease, cholecystectomy in relation to, 284
- Cortisone,
 - adrenal gland surgery, in, 263-264
 - suppression of inflammatory reactions, in, 289
- Cyanotic heart disease, congenital, hypothermic anaesthesia for, 177
- Cystectomy, construction of ileal bladder after, 167

D

- Dermoid tumours, diagnosis, 298
- Diaphragm,
 - funnel chest, in, 150-151
 - normal movements of, 150-151
- Dislocations, recurrent,
 - hip, 281
 - shoulder, 281
- Duodenum,
 - congenital atresia below, 291
 - obstruction distal to ampulla of Vater, 263
 - ulcer, 306
- Dupuytren's contracture, 287-288
- Dyspnoea in laryngeal paralysis, 225

E

- Ear, bat or winged, 75-77
 - dressings, post-operative, 77

INDEX

Ear, bat or winged—*continued*
indications for treatment, 75
technique of repair, 75-77
Ectopia vesicae, construction of ilcal bladder
in, 166
Embolectomy in aortic embolism, 267
Embolism,
aortic, 267
cerebral, haemorrhage, differentiation, 15
Empyema, chronic pleural, treatment, 308
Endometriosis, induction theory of implant-
ation in pathogenesis, 278
Enzyme production in pancreatitis, 252
Epididymitis, treatment of, 316
Eye emergencies, treatment of, 279

F

Femur,
benign giant-cell tumour, 271-272
displacement osteotomy for un-united
fractures, 282
liposarcoma of, 272
non-union after displaced fractures of
neck, 282
Fingers, melanoma of, 244, 246
Foot, melanomas of, 244
Funnel chest, 150-159
aetiology, 150
diagnosis, 153-154
diaphragm movement in causation, 150-
151
examination, clinical, in, 153-154
mechanics of production, 150-151
photographic records in, 154
radiography in, 154
recurrence after operation, 159
symptomatology, 153
treatment, surgical,
anaesthesia for, 155-156
complications, post-operative, 159
indications for, 154-155
post-operative care, 159
results, 155, 159
technique, 156-158
closure, 158
costal cartilages, removal of, 158-159
drainage, 158
incision, 156
perichondrium, dissection of, 157
pleural injury, 158
sternum, osteotomy, 157
types of deformity, 152-153

G

Gall bladder and bile passages,
cholangitis treated by choleduodenostomy,
284
cholecystitis, 283
cholelithiasis, 283
coronary disease and cholecystic disease,
284

Gall bladder and bile passages—*continued*
diagnosis and treatment in, 283
neoplasms, study of 113 cases, 285
surgery in 1954, 283
Gastrectomy, 307
partial, complications, of, 315
pulmonary tuberculosis following, 305-306
Gastric ulcer, 305-306
Gastrojejunocolic fistula, unusual cases, 286
Gougerot-Sjogren's disease, 130-131
Gunshot wounds, 286-287

H

Haematoma,
intracerebral and subdural, treatment, 31
posterior fossa, of, 273
Haemorrhage,
gastro-intestinal, massive, 306-307
spontaneous intracranial, 1-32
aetiology, 1-5
aneurysms, berry, due to, 1-3
angiomas, due to, 3-5
blood diseases, due to, 5
diagnosis, clinical, 5-19
aneurysms, 9-13
angiomas, of, 13
blood diseases, 13
causative lesion, of, 9-13
hypertensive cerebrovascular disease,
of, 13
site, of, 5, 9
differential diagnosis, 13-16
embolism, differentiation, 15
epilepsy, differentiation, 16
extradural haemorrhage, 273
haematoma formation, 273
hypertensive cerebrovascular disease,
due to, 5
intracerebral and subdural haematomas,
due to, 9, 31
lumbar puncture in diagnosis, 5-6
meningitis, differentiation, 16
morbidity, 19
treatment, of, 19-26
"ophthalmoplegic migraine", differen-
tiation, 16
pathology, 1-5
prognosis, 18-19
radiological diagnosis, 6, 7, 8, 10, 11,
12, 14, 15, 16-17
plain x-rays, 16
angiography, 16-17
subarachnoid haemorrhage, diagnosis, 9
thrombosis, differentiation, 15
treatment, 19-31
angioma, of, 26-31
tumour,
differentiation, 16
due to, 5
unknown causes, from, 5

Hand,

Dupuytren's contracture, 287-288
infections, diagnosis and treatment, 287

INDEX

- Hashimoto disease, lymphosarcoma and, relationship, 317
- Head injury, delayed complications of, 273
- Heart,
atrial septal defects, repair under direct vision, 322
surgery, intracardiac, 323
tricuspid stenosis, acquired, 322
- Hemiplegia, carotid artery ligation causing, 21
- Hernia,
inguinal, herniorrhaphy for, 288
problems in treatment, 288
retromesocolic, 289
- Herniorrhaphy, inguinal, 288
- Hiatus hernia, 61-71 (*see also* Oesophagus, competence of cardia)
- Hips,
arthrodesis, 268
recurrent dislocation, 281
- Hoover's operation for laryngeal paralysis, 231-233
Lawson's modification, 232
Lore's modification, 232
Young's modification, 232
- Hydrocortisone, adrenal gland surgery, in, 263-264
- Hypothermic anaesthesia, 177-188, 264-265 (*see also* Anaesthesia)
- I
- Ileum, transplantation of ureter into, 162-176 (*see also* Ureter)
- Intestines,
atresia below duodenum, congenital, 291
benign tumours of, 289-290
malignant argentaffinoma of, 290
mesenteric venous thrombosis, primary, 290
- Intussusception, recurrent ileocolic, 291
- J
- Jaundice, obstructive,
decompression of hepatic duct system in, 292
diagnosis, 291-292
- Jaws,
adamantinoma, 300
epithelial cysts of, 300
multiple dental cysts, 300
- Johannesburg stapling operation for recurrent dislocation of hip, 281
- Joints, tuberculosis, arthrodesis combined with anti-tubercular drugs in, 293
- K
- Kelly's operation for laryngeal paralysis, 229
- Kidney,
calculi, localized, 189-204
aetiology, 189-196
Carr's stones, 190
classification of, 200-201
microradiography in, 196
partial nephrectomy in, 196
pathological changes, 196
- Kidney—*continued*
calculi, localized—*continued*
primary stones, 189-196
Randall's stones, 190
retention in terminal calyx, 200
sites, 198
treatment of primary stone, 201
uretero-pelvic, treatment, 201, 202
cyst, solitary, treated by partial nephrectomy, 211
hydrocalyx, localized, treated by partial nephrectomy, 211
infarction, 211
laceration, treatment, 211
tuberculosis, 294-295
partial nephrectomy, for, 205-211 (*see also* Nephrectomy)
treatment, 294-295
chemotherapy, comparison with other methods, 295
PAS in, 295
results of, 294
selective principle in, 294
tumours, nephrectomy, partial, for, 212
King's operation for laryngeal paralysis, 228-229
- L
- Labour, anaesthesia for, 265
- Laminectomy, results of late, 312
- Larynx, paralysis, 224-235
bilateral abductor, 224-225
dyspnoea due to, 225
stridor due to, 225
symptoms, 225
vocal changes in, 225
central, 224
peripheral, 224
treatment, surgical, 225-235
anastomosis of nerve, 226
arytenoidectomy, 230
thyrofixure, by, 230
choice of method, 233-234
cordopexy,
anterior, 227
posterior, 227-230
extra-laryngeal route, 227-228
Hoover's operation, 231-233
Lawson's modification, 232
Lore's modification, 232
Young's modification, 232
Kelly's operation, 229
King's operation, 228-229
section of damaged nerve, 226-227
submucous excision of vocal cord and arytenoid cartilage, 231-233, 234, 235
suture of nerve, 226
Thornell's operation, 230-231
tracheostomy, preliminary, 226
ventriculectomy or ventricle stripping, 227
vocal cords, excision of, 227
Woodman's operation, 230
types, 224

INDEX

Leukaemia, intracranial haemorrhage due to, 5, 13

Levator ani, rectal prolapse, in, 109-110

Lip, flat tight upper, 72-75 (*see also* Abbé operation)

Lobectomy, 310

Lumbar puncture, in diagnosis of intracranial haemorrhage, 5, 9

Lungs, tumours,
asymptomatic cancer, treatment, 296
cytology of sputum in, 295-296
occupation and smoking in relation to, 296

Lymph fistula, post-operative, case reports, 278

Lymphatic glands, excision in treatment of melanomas, 243

M

Masseter, hypertrophy, differentiation from parotitis, 127-128

Maxilla, carcinoma of, 33-47
deformity due to, 33-34
diagnosis, 35-36
incidence, 34-35
joint consultation clinics and, 45
prognosis, 36
radiography in diagnosis, 36
spread of, 35
symptoms and signs, 35
technical considerations affecting treatment, 41-45
treatment, 36-41
ethmoid tumours, 40
external defect, of, 43-44
haemorrhage, control of, 41
maxillary antrum, in, 36-40
surgery and radiotherapy, 37
metastases, of, 37-38
nasal fossae, palate and alveolus, of, 40-41
palatal and alveolar defect, of, 43
pedicle flaps in, 44
recurrences, of, 38-40
rodent ulcers, of, 41
secondary carcinoma, of, 41
skin grafting in, 41
technical considerations, 41-45
types of growth, 33

Megacolon,
megaloureter, associated with, 277
radiological investigation of, 277

Melanomas, 236-248
age incidence, 236
frequency of, 236
histological examination prior to treatment, 242, 243
moles, differentiation, 236
pregnancy in relation to, 237, 240, 242
radiographic appearances, 241
radiotherapy, 240
scar formation, and, 238, 240
spontaneous regression following pregnancy, 240

Melanomas—*continued*
spread, mode of, 237-240
deep involvement, 239
distant metastases, 238-239
incubation period, 237
local, 237-238
lymphatic, 238-239
sites affected, 240
surgical treatment, 240-248

genital melanomas, of, 247
indications, 240
late results of, 248
nerve section in, 247-248
oral melanomas, of, 247
pregnancy, during, 247
pre-pubertal melanomas, of, 249
principles, 238

Mikulicz disease, 130

Moles, 236 (*see also* Melanomas)
melanomas, differentiation, 236

Mouth,
malignant disease, evolution of surgery in, 297
melanomas, 247

Muscles,
malignant tumours of, histogenesis, 297
testing in poliomyelitis, 83
affected muscles, 87-89

N

nephrolithotomy in relation to, 204
pathological changes and, 196
primary stones, 189-202
pyelolithotomy, in relation to, 204
recurrence rate after, 196-197
causes, 204
prevention, 204
retention in terminal calyx, 200
secondary stones, 202
segmental resection, 199
site of stone formation, 198-199
treatment of primary renal stone, 201
uretero-pelvic calculi, treatment of, 201
202
catheterization after, 222
closure, 220-221

Nephrectomy, partial—*continued*
 complications, 222–223
 definition of procedure, 189
 drainage after, 222
 exposure and mobilization of the kidney, 213–214
 haemorrhage complicating, 217–218, 222
 haemostasis during, 216–217
 hydrocalyx, localized, for, 211
 incision, 213, 218–219
 indications, 189–212
 infarcted kidney, for, 211–212
 infection, control of, 212–213
 median portion, resection of, 220
 mortality, 222
 positioning of kidney after operation, 221
 principles of operation, 212–222
 solitary cyst, for, 211
 sutures, type of, 221
 tissue necessary to sustain life, 212
 tuberculosis, for, 205
 advantages over nephrectomy, 205
 choice of case, 205–210
 contra-indications, 205–206
 201–210
 210–
 211
 tumours, for, 212
 upper pole, resection, 220
 wedge or cuneiform resection, 190
 x-ray examination of the exposed kidney during, 214–216
 Nephrolithotomy in relation to partial nephrectomy, 204
 Nephropexy, nephroptosis treated by, 293
 Nephroptosis, nephropexy in treatment of, 293
 Neuroblastoma in childhood, 264
 Neurofibromatosis, multiple, 299
 Neurosurgery, hypothermic anaesthesia, in, 178

O

Oesophagus,
 atresia, 47–60
 bronchiectasis, post-operative, 60
 clinical picture, 48–49
 complications, post-operative, 58–60
 congenital, 301
 diagnosis, 51
 dysphagia complicating treatment, 60
 ileus, post-operative, 60
 leakage from anastomosis after treatment, 58
 pathology, 47–48
 physiology, 48–50

Oesophagus—*continued*
 atresia—*continued*
 post-operative care, 54–56
 circulation and fluid balance, 57
 feeding technique, 58
 respiration, and, 57
 pre-operative management, 51–52
 radiological appearances, 49, 50, 51
 reconstructive technique, 52–54
 anaesthesia, 52
 approach, 52–53
 resuscitation measures, 52
 stenosis complicating treatment, 58
 tracheal fistula complicating treatment, 60
 carcinoma of, 301
 palliative segmental resection for, 301
 competence of cardia in hiatus hernia, 61–71
 function of cardia, 67
 hiatal muscle, role of, 61
 ligaments, role of, 62–64
 mechanism of, 61
 muscles, role of, 61–67
 oblique gastric muscle, role of, 64–67
 phreno-oesophageal ligament, role of, 63
 restoration of competence, 67–71
 complications preventing, 67
 conditions for, 67
 results of, 71
 submucosa, role of, 66
 surgical technique, 68–70
 regurgitant ulcer, 301
 Osteochondritis,
 dissecans of talus, 268
 vertebral, 313
 Osteogenic sarcoma, 271
 Ovary, tumours,
 post-operative irradiation of, 302
 prognosis, 302
 rhabdomyosarcoma of, 302–303
 teratoma, thrombosis, and, 317

P

Pancreas,
 adenocarcinoma in relation to thrombosis, 317
 cysts of, 303
 islet-cell tumour of, 305
 pancreatitis, 249–262, 304–305 (*see also* Pancreatitis)
 pancreatography in investigations, 303–304
 peptic ulcer perforating into, 300
 surgery in 1954, 283
 Pancreatitis, 249–262
 aetiology, 249–251
 age incidence, 251
 alcoholism, role of, 251
 bile reflux theory of origin, 249–250
 biopsy in, 259

INDEX

Pancreatitis—*continued*

- clinical aspects, 251-252
- diagnosis, 305
- exploration for obstruction, 259
- gall-bladder disease, associated, 251
- metabolic study in, 305
- obstruction in aetiology, 250
- Pezzar catheter drainage in, 254, 258
- protein deficiency in, 251
- recurrent or relapsing, 254-260
 - case reports, 254, 255, 257, 258, 260
 - cause of, 254
 - cholangiography in, 255, 256
 - cholechole-oduodenostomy, side-to-side, for, 257
 - pancreatectomy, indications for, 260
 - pancreatico-jejunosomy, 259
 - sphincterotomy for, 256, 257
 - surgical treatment, 254-260
 - sympathectomy in control of pain, 260
 - treatment, procedures used, 254-260
 - T-tube drainage, 255
- serum amylase estimation in diagnosis, 252
- sphincter spasm in causation, 257
- symptomatology, 252
- trauma in causation, 251
- treatment, 252-254
 - antibiotic, 253
 - choice of, 260
 - cholecystostomy, 254
 - cysts, of, 258
 - electrolyte levels, control of, 253
 - pain, relief of, 253, 260
 - prevention or reduction of enzyme production, 252-253
 - supportive therapy, 253
 - surgical, 253-254
- vascular theory of causation, 250

Pancreatography, 303

Paralysis,

- laryngeal, 224-235 (*see also* Larynx)
- poliomyelitis, in, 83-103 (*see also* Poliomyelitis)

Paraplegia, traumatic, 133-149

- cord and root lesions, differentiation, 134-135
- crush fractures and spinal stability, 138
- diagnosis, 134
- early effects of injury, 133
- fracture dislocation and spinal stability, 138-139
- leg, segmental innervation of, 142
- ligamentous injury in, 140
- nerve root injury, 133
 - diagnosis, 137-138
- results of late laminectomy, 312
- "spinal shock" in, 135-137
 - concussion of cord, due to, 137

- temporary, 135-137
- treatment, 140-148

Paraplegia, traumatic—*continued*

treatment—*continued*

- bedsores, avoidance of, 143-144, 146
- bladder, care of, 147-148
- catheterization, intermittent, dangers, 147
- division of cord, of, 142
- dorsal injuries, of, 142-143
- dorso-lumbar injuries, of, 143
- indwelling catheter bladder drainage, 148
- lumbar injuries, of, 143
- nursing care, 146-147
- operative reduction and internal fixation, 144-146
- partial division of cord, of, 143
- physiotherapy, 148
- plaster beds, 143
- plaster jackets, 143
- position of patient, changes in, 147
- stabilization of spine, 143-144
- Styker frame, use of, 144
- suprapubic bladder drainage, 148
- vertebrae, roots and cord, relationship, 135, 141

Parotid gland,

- fatty infiltration simulating mixed tumour, 311

sialoangiectasis, pathology, 312

Parotitis, 115-132

- acute suppurative, treatment, 312
- bacterial, 115
- cachectic, 116
- calculus formation, secondary to, 118-119
- gangrenous, 116
- infective, 115-118
 - radiographic appearance, 116
- mumps, 115
- post-operative, 115
- recurrent or chronic, of obscure origin, 119-131
 - aetiology, 127-131
 - clinical pictures, 120-121
 - differential diagnosis, 127
 - Gougerot-Sjogren's disease, and, 130-131
 - histology, 123-127
 - macroscopic appearances, 124
 - masseteric hypertrophy, differentiation, 127
 - Mikulicz disease, and, 130
 - mumps, differentiation, 127
 - obstructive factors in causation, 127-128
 - pathological anatomy, 123-127
 - lymphoid replacement, 123-125
 - radiological appearances, 121-123
 - saliva in aetiology, 130
 - sialography in, 121-123
 - treatment, 131
 - tuberculous, 116
 - viral, 115

Patella, recurrent dislocation, surgical treatment, 280

INDEX

- Pectus excavatum, 150-159 (*see also* Funnel chest)
- Pelvic exenteration, construction of ileal bladder after, 166
- Peptic ulcer,
haemorrhage from, 306-307
perforation into pancreas, 306
surgical treatment, 307
results, 306
subtotal gastrectomy, 307
tuberculosis following gastrectomy for, 305
- Peripheral nerve injuries, two-stage operation with minimal traction injury, 299
- Peritonitis, acute chylous, 307-308
- Pharynx, malignant disease, evolution of surgery in, 297
- Plastic procedures, 72-82
- Pneumonectomy, 310
- Poliomyelitis, distribution of paralysis in, 83-103
acute and convalescent stage, 83-86
aparalytic poliomyelitis, and, 102
associated paralyses, 100-101
clinical, 86-94
convalescent stage and, 102
deformity, anticipation, and, 103
diagnosis in relation to, 102
initial paralysis, 83
limbs, comparison between upper and lower, 86
lower limb, patterns in, 86-87, 89-94
muscles in,
affected, 85-89
associated paralyses, 89
lower limb, in, 87
upper limb, in, 88
imbalance in relation to, 102-103
testing, importance of, 83-84
paralysed muscles, recovery of, 85-86
paretic muscles, recovery of, 84
pathological basis for, 94
patterns of paralysis in the lower limb, 89-94, 101
above knee, 92-94
hip abduction and adduction, 93
hip abduction or extension, 93
hip flexion and abduction and knee extension, 94
hip flexion and knee extension, 93
isolated paralyses, 94
knee extensors, 93
knee flexors and extensors, 93
severe paralysis, 92
below knee, 90-92
dorsiflexion, 90-91
dorsiflexion and plantar flexion, 91
dorsiflexion, inversion and eversion, 90-91
eversion, 91
inversion, 90
long toe flexor muscle, 92
no paralysis below the knee, 92
- Poliomyelitis, distribution of paralysis in—
continued
patterns of paralysis in the lower limb—
continued
below knee—*continued*
plantar flexion, 91
plantar flexion and eversion, 91
plantar flexion and inversion, 91
95-96
cell columns representing muscles, 97
method of study in, 96
motor-cell columns of the lumbo-sacral spinal cord, 97
muscle power in relation to residual cells, 99
sites of motor cell destruction, 97-99
splinting in, value of, 305
upper limbs, 88-89
Pregnancy, melanomas, and, 247
Prolapse, rectal, 104-114 (*see also* Rectum, prolapse)
- Prostate,
carcinoma of, orchidectomy and stilboestrol therapy for, 309
resection of median bar, 308-309
- Prostatectomy,
radical retropubic,
morbidity, 309
results, 309
suprapubic, 310
transurethral, 308, 310
- Pyelolithotomy, partial nephrectomy in relation to, 204
- ## R
- Radiotherapy for intracranial angioma, 29
- Randall's stones, 190
- Recto-sigmoidectomy in rectal prolapse, 110
- Rectum,
artificial bladder, as, 163
biopsy in ulcerative colitis, 275
prolapse, 104-114
abdominal operations for, 110-114
anterior resection for complete prolapse, 110-114
advantages, 114
criticisms of, 114
position of rectum after operation, 112
complete, 105-110
anatomy in relation to, 106-107
peritoneal pouch, and, 104-107
radiographic appearances, 106-107

INDEX

Rectum—*continued*
 prolapse—*continued*
 partial, 104–105
 adults, in, 104
 anal incontinence, with, 105
 normal sphincter, with, 104
 treatment, 105
 infancy, in, 104
 post-operative care, 113
 recto-sigmoidectomy, for, 110
 villous tumours, treatment, 311
 pathology, 79
 post-operative care, 79
 technique, operative, 79

Saddle nose, 79–82
 causation, 80
 indications for operation, 80–81
 operative technique, 81–82

Salivary glands,
 calculi, 118–119
 parotitis, 115–132 (*see also* Parotitis)

Serum amylase in diagnosis of pancreatitis, 252

Shoulder, recurrent dislocation, 281

Sialectasis, 121–122

Sialography in parotitis of obscure origin, 121–123

for, 166

Spinal canal, dilatation at thoraco-lumbar junction, 313

Spinal column,
 crush fracture, 138
 fracture dislocation, 138
 operative reduction and internal fixation, 144–146
 stabilization, 143–144

Spinal cord,
 early effects of injury, 133
 nerve root injury, 133
 poliomyelitis, in, 95–100
 tumours causing compression, 313

“Spinal shock”, 135–137

Spleen,
 indications for splenectomy, 314
 rupture of, 314

Splenectomy, indications and results, 314

Stellate ganglion block, 266

Sternum, angulation in funnel chest, 152

Stomach, damage of the

Subphrenic abscess, 315
 spread of infection to chest, 315

Sympathectomy, posterior upper thoracic, improved method of approach, 269

T

Tenosynovitis, pigmented villo-nodular, 298

Testicle, imperfect descent of, 316

Thiopental, labour, for, 265

Thorax, congenital deformities, 150–161
 deficiencies of chest wall, 160–161 (*see also* Chest wall)
 funnel chest, 150–159 (*see also* Funnel chest)

Thorax, gunshot wounds, 286

Thornell's operation for laryngeal paralysis, 230

Thrombosis,
 intracranial, differentiation from haemorrhage, 15
 malignant disease, in, 317

Thumb, melanomas of, 245

Thyroid gland,
 malignant tumours, 317–319
 children, in, 318
 conservative operation, results of, 318
 lymphosarcoma and Hashimoto disease, 318
 radio-iodine treatment of metastases, 319

Thyroidectomy, bilateral abductor paralysis due to, 225

Tracheostomy in laryngeal paralysis, 226

Tricuspid stenosis, acquired, 322

Tuberculosis,
 joints of, arthrodesis combined with anti-tubercular drugs, 293
 pulmonary, segmental and wedge resection, lobectomy and pneumonectomy, 310–311
 renal, treatment, 294–295

U

Urachus, carcinoma of, 269

dis-

electrolytic imbalance following uretero-colic anastomosis, 164
 ileo-caecal region as artificial bladder, 163
 ileum, into the, 162–176, 319
 apparatus for collection of urine, 173
 artificial bladder, principles and considerations affecting, 163
 changes consequent on, 165–166
 collection of urine after, 173–174
 complications arising from, 172
 cystostomy for carcinoma, following, 167
 ectopia vesicae in adults, for, 166–167
 pelvic extenteration, in, 166

INDEX

- Ureter**, transplantation—*continued*
ileum, into the—*continued*
potassium absorption in, 165
preparation of the patient for, 168
pyelography, post-operative, 319
reservoir function of ileal bladder, 175–176
results, late, 174–175
spina bifida, for, 166
technique, operative, 168–175
anastomosis of ureters, 170, 171
division of the ileum, 168
division of ureters, 169–170
ileostomy stoma, formation of, 170
incision, 168
restoration of continuity of intestine, 169
spout ileostomy, 171
uretero-colic anastomosis, for, 166
- sigmoid, into, 320
uretero-colic anastomosis in relation to,
162–163, 164
changes due to, 164
Uretero-colic anastomosis, principles, 162–163
- Uretero-ileostomy**, 319
Uretero-sigmoidostomy, 320
Ureterostomy, bilateral cutaneous, disadvantages, 162
- Urethra**,
diverticulum of the anterior portion, 320
- V**
- Veins**, varicose, conservative and surgical treatment, 324
Ventricular fibrillation due to hypothermic anaesthesia, 181–182
treatment, 183
Ventriectomy in laryngeal paralysis, 227
Vesico-vaginal fistula, construction of ileal bladder for, 166
Vocal cords, excision in laryngeal paralysis, 227
Vulva, carcinoma of, 286
- W**
- Woodman's operation** for laryngeal paralysis, 230

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